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THE
Electrical Philoſopher.

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CONTAINING,

A New Syſtem of Phyſics, founded upon the Principle of an *univerſal Plenum of elementary Fire:* Wherein the Nature of elementary Fire is explained, its Office pointed out, its extenſive Influence and Utility in explaining many of the moſt abſtruſe Phenomena of Nature ſhewn, and the *Grand Deſideratum* in particular, which has been hitherto either entirely given up as inexplicable, or elſe ſought after in vain by the moſt able Naturaliſts, is at length happily obtained, *viz.* The *Cauſe* of *Gravity*, the *Cauſe* of *Coheſion*, &c. &c.

The greater Part of the Publication is diſpoſed in the Form of a Dialogue, as the moſt familiar Method of conveying Inſtruction; and the whole is offered to the Public by Way of Supplement to the PHILOSOPHICAL ESSAYS lately publiſhed by the ſame Author.

To which is ſubjoined,

A POSTSCRIPT,

Containing Strictures upon the *uncandid Animadverſions* of the Monthly Reviewers on thoſe ESSAYS.

By *R. LOVETT*, Lay-Clerk of the Cathedral-Church of WORCESTER.

The SECOND EDITION.

WORCESTER:
Printed for, and Sold by the AUTHOR, in Sidbury.——Sold alſo by Mr. BEW, and Mr. BLADON, in Pater-noſter Row, London.

MDCCLXXVII.

TO THE
RIGHT REVEREND FATHER IN GOD
JAMES,
LORD BISHOP
OF
WORCESTER,
THIS ATTEMPT TO PROMOTE USEFUL KNOWLEDGE,
BY ESTABLISHING
NATURAL PHILOSOPHY
UPON
A FIRMER AND MORE RATIONAL BASIS
THAN THAT ON WHICH IT IS FOUNDED AT PRESENT,
IS,
WITH THE GREATEST RESPECT AND VENERATION,
INSCRIBED,
BY HIS LORDSHIP'S
Moſt obliged and obedient
humble Servant,
RICHARD LOVETT.

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PREFACE
TO THE
SECOND EDITION.

A Careful Reviſal of the Firſt Impreſſion of my ELECTRICAL PHILOSOPHER, in order to prepare it for a Second Edition, furniſhed me with a better Opportunity for re-conſidering every Part of it, than any other Expedient would probably have done; and I cannot help informing my Readers of the remarkable Satisfaction it gave me; particularly, at finding all, or moſt of my former Thoughts and Experiments verified and confirmed by ſucceeding ones: A Satisfaction that I am perſuaded few Electricians beſides ever experienced; notwithſtanding I muſt own myſelf vaſtly inferior to many of them, both as to natural and acquired Abilities.

My Reaſon for believing that others have not met with the like Satisfaction is, that few, if any, which we hear of, purſue their Enquiries on the ſame Plan; *i. e.* who undertake to examine into the Nature and eſſential Properties of the electrical ſubtile Medium, with the ſeveral

Uſes it was ordained to ſerve in the Creation; but ſo averſe are they to ſuch an Enquiry, that they loudly exclaim againſt my attempting it ſo ſoon, and before a ſufficient Number of proper Experiments have been made.—But methinks I ſhould be glad to be informed how long Time is ſtill wanted, and how many more Experiments? ſince the Time is now protracted to upwards of thirty Years ſince the grand Leyden Experiment was diſcovered, beſides all the ſubſequent ones that have been made: And though, as a judicious Writer obſerves, they have been ever ſince ringing, as it were, a perpetual Round of Changes on electrical Experiments; yet they ſeem not to be advanced a Jot the forwarder; but are ſtill, as at firſt, crying out for Want of Time to make more. Finding ſo great a Reluctance to an Enquiry into the Uſes of the electrical Fire, brought to my Mind an Obſervation of the ingenious Dr. *Franklin*, ſoon after the firſt Diſcovery of Electricity ——" The beneficial ' Uſes of the electrical Fluid in the Creation ' we are not yet well acquainted with, tho'," he ſays, " doubtleſs ſuch there are, and thoſe ' very conſiderable." See the 2d Edition of his Letters, p. 53, ſect. 10.

But though it might well be ſuppoſed, that ſoon after the firſt Diſcovery of it ſuch beneficial Uſes were not to be expected, yet ſurely in the Space of almoſt thirty Years after, it might be reaſonably expected to find inquiſitive Mankind making at leaſt ſome Enquiries after its Office, and the Uſes for which it was ordained.

This Diſcovery of Fire, although the moſt intereſting and the moſt ſerious of all others, is nevertheleſs treated in the moſt ludicrous Manner; being called a Plaything, a Hobby-horſe, *&c.* and that it is now high Time it was done with, or thrown into a Corner along with other old Playthings. — Mean Artifice indeed! —— Throw it into a Corner! — That however, or any thing elſe, ſo it be but forgotten.——But Fire will never be forgotten, ſo long as Electricity, which diſcovered it to be permanent, can be remembered.

It is notorious to all the moſt curious Obſervers of Nature, that Electricity has opened the moſt ſpacious Field for philoſophical Enquiries that ever was or could be known, by which means many of the moſt inſuperable Difficulties in natural Philoſophy diſappear. But the principal Reaſon which inclines me to believe my Satisfaction is greater than that of other Electricians, is, that my Method of examining Experiments is different; for which I am indebted to the ingenious Mr. *Haukeſbee.*—In Sect. III. p. 88, of his Phyſico-mechanical Experiments, he juſtly obſerves, “ That the beſt Proof which ‘ can be given of the Truth of any Hypotheſis ‘ is, that the Experiments made for that End ‘ do all of them, and every Way agree; that

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'trying Nature on the one Side and the other, 'and ſhe ſtill confeſſes the ſame Thing;" that is, by varying and diverſifying the Experiments: The more they are varied, the leſs Danger of Errors there will be when the Concluſions are drawn. And thus extorting the Truth from the Experiments, enabled me to find myſelf happily conducted to the proper Channel for philoſophiſing aright.

Many former Philoſophers were greatly perplexed, when they attempted to explain and account for the Mechaniſm of Nature; but ſince the late Diſcovery of an elaſtic ſubtile Medium, electrical Philoſophers can ſafely undertake to account for a Variety of Things, which were entirely given up before as inexplicable; not only the Origin of Motion, but even the *Cauſe* of Gravity, as well as that of Coheſion, and in a natural Way; as may be ſeen diſcuſſed in the 11th and 12th Dialogues of the enſuing Work.

As for a general mechanical Agency throughout the Operations of Nature, almoſt all Obſervations and Experiments made by Way of Examination, either ſtrengthen or confirm it; and that all Things ſeem to be made, as it were, by Number, Weight, and Meaſure.

When I was treating of the Laws of Motion, one Thing, of no ſmall Importance it muſt be confeſſed, was inadvertently omitted; which was, The great Law of the Planetary Motions: That the Square of their Periods in their Orbits is ever as the Cube of their Diſtances from the Sun; *i. e.* the Square of their periodical Revolution in Days, is always in geometrical Proportion to the Cube of their ſeveral Diſtances in Miles from the Sun or Center.—And this Proportion is ſo univerſal, that it obtains not only in the general Syſtem of the primary Planets about the Sun, but in the particular Syſtems of the ſecondary Planets about their Primaries; and that in their Revolutions, they deſcribe equal Areas in equal Times.——Thoſe Laws of Motion are generally known by the Name of *Keplar's* Laws, for to him we are indebted for the firſt Diſcovery of them.

Thus much was thought neceſſary to be remarked, previous to the Second Edition; ſince it was not inſerted in a more proper Place in the Firſt Impreſſion.

* * *

To the READER.

ALTHOUGH an Enquiry into the Nature and important Uſes of the electrical Fluid, may juſtly claim the Abilities and Addreſs of a firſt rate Writer; yet ſince no ſuch has appeared willing to undertake it, I cannot help thinking *myſelf* under ſome Obligation to engage in it, ſo far at leaſt as may be thought conſiſtent with a Supplement to my former Writings on that Subject; in which I had always in View that which ſeems to have been too ſtudiouſly avoided by others; *viz.* the Uſes which ſuch an amazing Inſtrument of Nature was ordained to ſerve in the Creation: Which Uſes are doubtleſs adequate to the Greatneſs and Extenſiveneſs of its Power.

That ſo few Enquiries have been made concerning its Nature and Uſes, ſeems the more unaccountable, ſince Myriads of Experiments have been made, all of which invite, as it were, our Reſearches into ſo curious a Subject.—— Can any thing then, but an invincible Prejudice in Favour of preconceived Opinions, be imagined to be the *Cauſe* of ſuch a Reluctance to the inveſtigating of an Object ſo promiſing and ſo intereſting as elementary Fire appears to be? (*a*)

(*a*) A principal Reaſon for calling electrical Fire elementary, is its great Purity and Univerſality, and its appearing in Form of Air.

To the READER.

How aſſiduous were Philoſophers, particularly Mr. *Boyle*, in cultivating and improving the *Pneumatic Engine*; and with what unwearied Diligence did he purſue the Experiments made therewith; altho' the moſt he could propoſe from them was the enquiring into the Nature and Properties of the *common* Air? How much more then might be reaſonably expected when, by means of the *Electrical Engine* we had diſcovered the pure, primary, elementary Air or Æther? Was it not reaſonable to think that Philoſophers would have exulted at the Diſcovery, and doubled their Diligence in their Enquiries into the Nature of a Principle which they always before imagined had no Exiſtence? ——But inſtead of availing themſelves of a *Light* which unexpectedly appeared, in order to conduct them to Truth, they ſeem to have ſitten ſupinely for near thirty Years after the Diſcovery, as if nothing had happened worthy their Notice. Such thoughts brought to my Mind an Obſervation of the Rev. Mr. *Jones*, *viz.* "Electricity, which has given 'to this Age an Advantage over all that went 'before it, and ſhould have opened to us a 'new World of Philoſophy, has left us juſt 'where it found us:" And there we muſt neceſſarily remain, till we can prevail with ourſelves to cultivate and improve the Diſcoveries already made, and begin the Search of Nature afreſh.—I would not be underſtood by this to abandon Sir *Iſaac Newton*, but ſo far from it, that I am throughly convinced all Attempts will prove vain and fruitleſs, if we do not proceed upon his Principles.

Unleſs we purſue the Diſcoveries which Sir *Iſaac* has already made, it will be abſolutely impoſſible to underſtand the Nature of the *electrical Fluid,* ſo as to explain, in a ſatisfactory Manner, even the very Experiments which we are moſt familiar with.—What I mean by the Diſcoveries that Sir *Iſaac* has already made, is, Firſt, the inherent or natural Properties of Æther, *viz.* its indefinite Elaſticity and Rarity; and, Secondly, its Exiſtence in the Pores of all groſs Bodies. If theſe Things be not ſtrictly attended to, it will be in vain to attempt the Explanation either of the newly diſcovered *Fire,* or of the Experiments made with it.

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Such Aſſertions may probably be cenſured as the Effects of crude and precipitate Reflections; but I can with great Truth affirm, they are ſo far from *haſty* Thoughts, that they have been cultivated with the ſtricteſt and moſt deliberate Attention, and I am therefore very certain that the Experiments are not explicable on any other Principles whatever.—Surely the candid and judicious will not cenſure and condemn me for affirming ſo peremptorily, that which I am throughly convinced of from a Crowd of unbiaſſed Witneſſes: For if the Exriments are ever ſo much diverſified, they are ſure to ſtrengthen and confirm each other, when examined on the aforeſaid Plan; *viz.*

that of ſuch an indefinite Elaſticity and Rarity.

That ſo intereſting a Diſcovery has lain ſo long uncultivated by others, ſeems the more remarkable, when we reflect on the Jealouſies that have ſubſiſted among Men, when all that has been contended for was, perhaps, a little empty Honour of being the firſt Inventor of a Rule or Method for ſolving particular geometrical Problems (*a*); or being the Author of ſome new Diſcovery in Aſtronomy (*b*).

To find out the true Nature, and inherent or eſſential Properties of the electric Matter, has, I may truly ſay, been the principal, or rather

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(*a*) How great the Contention was between the *Engliſh* and *French* Geometricians, concerning the Invention of *Fluxions* is well known: The former maintaining that Sir Iſaac Newton was the Inventor of them; the latter, that they were invented by M. Leibnitz, an able French Philoſopher.

(*b*) Dr. Deſaguliers, after mentioning Dr. Bradley's Method of finding the annual Parallax of the bright Star in the Head of Draco, adds, "So that now the Motion of the Earth is ſettled by aſtronomical Obſervation. This Diſcovery, of ſo great Conſequence ‘ to Aſtronomy, which has been attempted in vain for many Ages, ‘ and at laſt made in the Year 1728, is yet mentioned no where that ‘ I know of, but in the *Philoſophical Tranſactions*. Had this been ‘ found out by ſome Foreigners, we ſhould have had whole ‘ Volumes written about it in a pompous manner before this time. ‘ —It is ſurpriſing that in the term of five Years, ſince the firſt Publication of it, none of the learned Gentlemen abroad have taken ‘ any Notice of it, either to object againſt, or acquieſce in it".

"This ſhows us, (he ſays,) that the Parallax of the fixed Stars ‘ is much ſmaller than has hitherto been ſuppoſed by thoſe who ‘ have pretended to deduce it from their Obſervations; for inſtead ‘ of many Seconds, it does not amount to one: Hence it follows, ‘ that the above-mentioned Star is above 400000 Times farther ‘ from us than the Sun."—See Dr. Deſaguliers on Experimental Philoſophy, Vol. I. page 386.

the ſole Object of my Attention and Study, almoſt ever ſince the great Force of the Leyden Phial was diſcovered; in order to enquire into the Difference of the Nature of the electrical Fluid and that of common Matter; the former of which is found to be endued with real Activity, whilſt the latter remains entirely paſſive and inert.

As Sir *Iſaac Newton* was the only one among modern Philoſophers who had ſtudied the Nature of ſuch a ſubtile Medium ſo far as to inveſtigate the Laws by which it was governed, I happily conſulted his Writings concerning it; happily I ſay, having ſince diſcovered it to be the only ſucceſsful Method I could have taken; for to him alone we are indebted for that which is ſince found to be the only guiding Clue to the moſt important Diſcoveries; that is, to thoſe inherent Properties of indefinitely great Elaſticity and Rarity of the ſubtile Fluid above-mentioned, of which we have, by means of electrical Experiments, made a moſt compleat Diſcovery.

To him alſo, and to him only, are we indebted for pointing out its Exiſtence in the Pores of all groſs Bodies. For the Inveſtigation of the former, ſee his Optics, Quære 21, or the Beginning of Chap. V. p. 67, of my Eſſays: And of the latter, ſee the concluding Paragraph of his Principia, or my Eſſays, p. 36, ſect 75.

Had it not been for theſe important Diſcoveries of Sir *Iſaac*, *electrical Philoſophers* as well as all others, had been intirely deſtitute of a ra-

tional

and of course of motion.

tional Method to explain any of the electrical Experiments, ſo as to render them reconcileable with one another; whereas, by means of the forementioned Aſſiſtance they are enabled, as with a Key, to unlock many of the greateſt Difficulties relating to electrical Experiments, which, as before obſerved, it would be in vain to attempt on any other Plan: And ſuch vain Attempts, I am fully perſuaded, are the only Reaſons why the electrical Fluid ſeems ſtill given up as inexplicable; And indeed, ever ſince the firſt Diſcovery of that wonderful Power of Nature, the *elementary Fire*, I have ſhewn as great a Propenſity to enquire into its Nature, Office, and the Uſes it was ordained to ſerve in the mundane Syſtem, as *others* have a Reluctance to ſuch an Enquiry.

I muſt further inform the Reader, that altho' the principal Part of this Supplement is intended to conſiſt of Dialogues, yet, as ſome Portions of it could not properly be digeſted into a colloquial Form, the whole is to be conſidered as a Miſcellany of Dialogues, Quotations, Recapitulations, &c. And I flatter myſelf ſuch an Indulgence will be readily granted me, when it is conſidered that I am the only one who has attempted to make a minute Enquiry into the Nature and Office of this univerſal Fire, and who am conſequently deſtitute of the common Privilege of other Authors, *viz.* that of conſulting the Writings of thoſe who have gone before them on the ſame Subject.

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But

But after every Indulgence I can hope for from the Public, I ſhall think it ever incumbent upon me to make the ſame Confeſſion which my Heart dictated to my Pen when I was engaged in the Publication of my Eſſays; *viz.* "That, ſenſible of my Deficiency, I think 'it my Duty to apologize for an Attempt of 'this Nature, rather than to plead any thing 'for the Merit of the Work." However, fired with a Love of Truth, and animated by the Candour and Encouragement of the moſt reſpectable and *diſcerning* Part of my Readers, I have ventured once more to crave their Attention to a Subject, which *my Want of Literature* in a great Meaſure diſqualifies me from doing that *Juſtice* to, which it deſerves and demands at our Hands. But Truth evidenced, by *Experiment*, will ſpeak beſt for itſelf, and needeth not thoſe Embelliſhments and Flowers of Diction by which alone *Hypotheſes* are generally ſupported: And I flatter myſelf that the Time cannot be very diſtant, in this illumined Age, when that *truly natural and rational Philoſophy*, which Electricity has pointed out to us, will be univerſally adopted and approved.

N. B. I cannot help remarking here in brief, that my Endeavours to elucidate this Subject have met with ſome Oppoſition; but whether my Reſearches ought to be diſcountenanced or encouraged, I ſhall leave to the judicious to determine; requeſting only of them, an attentive and candid Peruſal of the following Pages.

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INTRODUCTION.

INTRODUCTION.

MY Philoſophical Eſſays having been ſeven Years publiſhed, and notwithſtanding they have been ſtigmatized as heterodox, yet, as they have never been anſwer'd by way of ſerious Refutation, but on the contrary, honoured with Encomiums by various eminent Authors, amongſt whom were ſome of the moſt profeſſed and judicious Critics of the preſent Age, (a) I am encouraged to hope that they have been looked upon as founded on rational Principles, notwithſtanding their Variation from received Opinions: I ſhall however flatter myſelf that I have ſufficient Reaſon to think ſo, until ſuch Principles be diſproved and ſet aſide by more convincing Arguments, and ſupported by Experiments equally concluſive.

Since therefore they have been well received by many, and the peruſal of them recommended by impartial and learned Men, I am excited to put Pen to Paper again on the ſame Subject, more eſpecially as Experience and Obſervation have ſince furniſhed me with a Variety of other uſeful Diſcoveries, which enable me to illuſtrate and confirm what I before advanced: — What I have more to offer is therefore intended as a Supplement to thoſe Eſſays.

(a) The Authors of the *Critical Review* were ſo candid as not only to give a brief account of ſome of the principal parts of the Eſſays, but to conclude with a commendatory Character of them. ——See Critical Review for October 1766.

Being in company with a facetious ſpeculative Gentleman, and the Converſation happening to turn on Electricity, he declared that the Electrical Phenomenon ſeemed ſo ſurprizingly abſtruſe and myſterious, as in his Opinion never to be rationally accounted for on any natural Principles whatever, ſo as to be rendered intelligible.

I told him I was far from thinking ſo, and that the rendering it ſo plain as to be eaſily underſtood was the principal, or rather the only Reaſon why I undertook to write my Philoſophical Eſſays; and that I could not help thinking I had ſo far ſucceeded in the Attempt that little could be found wanting in them to render the Electrical Appearances and their Cauſes perfectly intelligible, particularly if they were peruſed attentively, and impartially examined with that view.

N. B. I ſhall proceed in the preſent Enquiry as if ſtill confabulating with the ſame Gentleman, by way of a familiar Dialogue between *A.* and *B.*

DIALOGUE I.

FIRE, *a permanent Principle.*---HEAT, *not an eſſential Property of* FIRE.----*The* PORES *of* WATER *replete with* FIRE.---QUICKSILVER *frozen.*

B. MY early Viſit, Sir, this Morning is occaſioned by what I have heard ſince our laſt Converſation.

I was mentioning in a ſelect Company what you advanced relating to Electricity, and they ſeemed to cenſure you, or rather to ſet you at nought, for theſe three Reaſons: *Firſt,* as an Innovator, that maintained heterodox Principles. *Secondly,* that you are too precipitant in your Application of the electrical Fluid, before a ſufficient Number of Experiments had been made to confirm ſuch reaſoning. *Thirdly,* that you expreſly aſſerted, that there was no Heat in Fire.

A. As for their *firſt* Reaſon, that of cenſuring me for maintaining Principles different from the Generality of Mankind; 'tis preſum'd I may appeal to all judicious and candid Men, whether it be a juſt Reaſon for Cenſure, if others have not made the ſame Enquiry into thoſe Things about which we differ.—Their *Second* Reaſon, that of being too forward in my Enquiry as to the Nature and Uſes of the electrical Fluid, before a ſufficient Number of Experiments have been made by Way of Examination into the Nature of it, I am at a Loſs to know, ſince Myriads of Experiments have been already made, and more are daily making.

Beſides I can aſſure them that ſuch a Multiplicity of Experiments are not abſolutely neceſſary; a few well choſen ones will be found to be abundantly ſufficient.—Nor can they ſay that a ſufficient Length of Time to make a fair Trial has been wanted; Experiments having been made with it conſiderably more than fifty Years ſince modern Improvements;—*Firſt*, by Mr. Haukſbee; next by Mr. Stephen Grey of the Charter Houſe; with Mr. Du Faye, and others.

As to their laſt Reaſon it will be neceſſary for me, in order to wipe off ſuch an Opprobrium from my Book, to inform the heedleſs and injudicious Reader, (for no other I may well ſuppoſe could miſtake my Meaning) that although it aſſerts that Heat is not eſſential to Fire, and produces a Variety of Inſtances to prove that in many Caſes Fire ſhews no Signs of Heat, yet at the ſame Time it maintains that the greateſt Heat of all is the Effect of Fire only, and ſhews by what means it was produced ; (a) therefore to prevent Errors of the ſame kind for the future, I am inclined to think it neceſſary for me to recapitulate ſome of thoſe parts of the Eſſays which relate more particularly to that Subject, eſpecially the Definition of Fire and Heat, and the Obſervation on cold Fire.—*Firſt* then,

“ *Fire is an Element in the ſtricteſt Senſe of the Word, and is conſequently a permanent Principle.*”

“ Secondly, *That it is in form of an exceedingly fine Air or Æther, and is by means of Electricity diſcovered to exiſt in the Pores of all groſs Bodies with which we are converſant.*”

“ Thirdly, *True Fire ſubſiſts without a Pabulum, and conſequently yields neither Smoke, Aſhes, nor any other groſs feculent Matter.*”

“ Which remarkable Purity we looked upon to be peculiar to the Solar Fire when collected in the Focus of a Burning Glaſs, or a concave Speculum, till the Electrical Apparatus opened another to our view, which appears to be equally pure with the Solar, and which may therefore be reaſonably ſuppoſed to be ſtrictly one and the ſame.”

(a) Witneſs Vilette's Mirror.

"Fourthly, *True Fire is either hot or cold,* (a) *according to the Temperature of the Body in which it exiſts.*"

"To theſe might be added thoſe eſſential Properties of indefinite Elaſticity and Rarity, ſince theſe are ſo abſolutely neceſſary, that without them there would be no ſuch thing as explaining any of the experiments in a rational and ſatisfactory manner."

"The Author thought a poſitive Definition of Fire to be neceſſary, ſince Elementary Fire is a Term frequently met with, but yet not always underſtood, even by thoſe who make uſe of it; and is therefore often taken in a vague ſenſe and in different

---

(a) "Here I expect, as I have formerly remark'd, to meet with the ſame fate which moſt others have done, who with an honeſt oppoſition to rooted Prejudices have dared to advance paradoxical Truths."

"Amongſt the various Methods adopted by ſhallow Minds for the deciding of Controverſies, there is none more frequently made uſe of by them than what is commonly term'd the HORSE-LAUGH. This, like an impetuous torrent, carries all before it: No remonſtrance of Reaſon, no ſtrength of Argument, can obtain the leaſt hearing in the tumultuous Uproar; nor ſhall I at all wonder if I experience the like treatment myſelf from the unthinking and prepoſſeſs'd Multitude, in whoſe injudicious and unphiloſophical ears, Cold Fire may ſound as the higheſt abſurdity, a contradiction in very terms. But the Approbation of ſuch incompetent judges is what I am not ſo ambitious of, as to offer an oblation, precious as Truth, at the Altars which their Fancies have erected. To my inquiſitive, diſcerning, and unbiaſs'd Readers I addreſs my Diſquiſitions on this intricate Subject, well knowing that they will examine with Temper, and decree with Juſtice."

" meanings: I have therefore confined it to " that particular and reſtrained Senſe which " only it properly bears; no Fire having a " right to the epithet pure, but that which " ſubſiſts, as above remarked, without a " Pabulum; nor did we know of any Fire " which had the leaſt pretenſion to ſuch a " Purity beſides the Solar, 'till we were " agreeably convinced to the contrary by the " Diſcovery of the Electrical Fire."

On HEAT and MOTION.

HEAT is an accidental Property or Quality of Fire, *generated at pleaſure by the mutual Attrition of the Particles of the Fire; or in other words, when Heat is produced by the Attrition of two Bodies, the ſtrict and proper cauſe of ſuch Heat is the mutual Attritition of the Particles of the Fire contained in thoſe Bodies, conſequently Heat is the effect of that mutual Attrition.*

Hence Heat is generated, increaſed, and continued in Proportion to the violence and continuance of that mutual Attrition of the Particles of the Fire; and we ſhall have ſufficient Reaſon to believe (when we come to ſhew the method by which the greateſt Heat was produced that ever has been known) that if it were poſſible to diveſt any two Bodies of the Fire contained in their pores or interſtices, no Heat at all would be produced by the Friction, though ever ſo violently and ever ſo long continued.

Hence alſo, though the vulgar expreſſion *hot as Fire*, implies that Heat is the very Eſſence of it, yet if we do but reflect on the Effects of the foregoing Experiments, we ſhall behold a cloud of Witneſſes all of them ready to teſtify, *that Heat is not an eſſential Property of Fire; for Fire is not always hot*, even when capable of melting Metals, if effected by Electricity. —— Dr. Franklin melted braſs Pins and ſteel Needles, Gold and Glaſs. "And though" ſays he "I have taken "up the Pieces of Glaſs between my Fingers "immediately after this melting; I never "could perceive the leaſt warmth in them." Dr. Franklin's Letters, Edit. 2d, p. 66.

Again, Tho' Water is naturally cold, yet we find the pores of no one thing more plentifully ſtored with Fire than thoſe of Water; nor is there any thing beſides Metals, from which pure Fire can be ſo plentifully obtain'd. Since then it always exiſts in Water while in a Fluid Form, who can doubt the truth of the Aſſertion of that great Experimentaliſt Dr. Boerhaave, viz. "that an incredible Quantity "of Fire is contained in the coldeſt maſſes

" of Ice, and may be inſtantly produced from
" them with a great deal of Violence?" (*a*)

But although it ſeems true from the Premiſes, that Fire is frequently COLD; yet that can be only in a limited Senſe, ſince Bodies are only comparatively *cold* or *hot*.

That which is greater than the heat of the human body we term *hot*, and that which is leſs, we term *cold*, though in a more unlimited Senſe, Fire may not improperly be ſaid to be always poſſeſſed of Heat and Motion too in ſome degree.

To render myſelf on this head the more plain and intelligible, I muſt tranſcribe another paſſage from the abovemention'd celebrated Author on Heat and Motion; tho' to ſay the truth, he confounds the terms Heat and Fire.

" There is ſtill another *motion*," ſays he, " which I aſcribe to Fire, which is the conſtant effect of its proper agility; and this is " moſt evidently demonſtrated by undeniable " Obſervations. Let us, for inſtance, conſider " Water when it is 33 degrees cold, and it " will then be in its coldeſt State; that is, it " will contain as ſmall a portion of Fire, as in " the nature of Things can poſſibly reſide in " pure Water; for if this ſimple Water be " effected with a greater degree of Cold, it " will not continue Water any longer, but be " converted into a pellucid brittle Subſtance

---

(*a*) Boerhaave's Elements of Chymiſtry, Dallowe's Tranſlation, p. 81.

" called Ice, though reducible again to Water
" by a heat of 33 degrees. Hence therefore
" it appears evident, that Water is Water
" only by the Motion of the Fire reſiding in
" it, and that it is not Water from its own
" Nature conſidered ſeparately and alone: The
" ſame is true of Glaſs, Foſſils, Sulphurs,
" Semi-Metals, Metals, and perhaps of all
" other Bodies, which appear in a conſiſtent
" form in a ſmaller degree of Heat, but are
" put in fuſion, and converted into a kind of
" Water if the ſame is increaſed to a certain
" degree, which will be different, according
" to the various Natures of the Subſtance
" under Examination. Since therefore by
" Fahrenheit's Thermometer the natural Heat
" has been obſerv'd 33 degrees below the
" freezing Point, hence we ſee evidently, that
" thro' all the difference of 33 degrees the
" Fire was agitated with a motion that grew
" gradually leſs and leſs, but was never totally
" deſtroy'd; and therefore even at that time
" when all Animals and Vegetables periſhed
" thro' the exceſs of the Cold, the Fire was
" not abſolutely at reſt. Therefore we may
" ſafely aſſert, that the Fire was even then in
" motion. But as it appears from Experi-
" ments, that this Fire may be diminiſh'd
" artificially ſtill 40 degrees more, we are
" hence certain, that Fire, in the greateſt
" natural Cold poſſible is agitated 40 degrees
" more than it is in this artificial one, and

“ that again thro’ every intermediate degree it “ is continually diſſolving ſome Bodies, which “ a little after in a ſmaller degree of Heat, “ appear of a ſolid Conſiſtence. Fire, there- “ fore, is perpetually agitated in the greateſt “ Cold, and ſtill gradually more and more in “ every increaſe of Heat; and conſequently is “ always hot and in motion.” See my Eſſays, Page 248, Section 160.

“ *N. B.* There is another fluid Subſtance not yet taken much notice of which requires the greateſt degree of Cold of all others to convert it into a ſolid, namely that of Quickſilver; which is of late Years found to become ſo by means of a certain degree of Cold, as well as Water and many other Things.——¶ *See an Account of Artificial Cold produced at the Royal Academy of Sciences at* Peterſburgh, *by Doctor* Himſelf. *In a Letter to Doctor* De Caſtro, F. R. S. *Tranſlated from the French by* James Parſons, M. D. F. R. S. *from the Philoſophical Tranſactions*.”

“ This Effect was produced by means of a freezing Mixture by which Fahrenheit’s Thermometer was reduced 65½ degrees lower than the 40 degrees before mention’d, the ſum of which is 105½—or to ſpeak more intelligibly, if Fahrenheit’s Thermometer is at 105½ degrees when the Mercury begins to freeze, and at 33 when the Water begins to freeze, conſequently the Motion and

Heat of the Fire contained in each will be as thoſe numbers, that is, the ſmalleſt degree of Motion and Heat, which is juſt ſufficient to melt the ſolid Quickſilver, and the increas'd Motion and Heat, which is juſt ſufficient to melt the ſolid Water, are as the number 105½ and the number 33."

" From ſuch a method of Reaſoning, we may conceive all the different degrees of Motion and Heat in agitated Fire, from the leaſt to the greateſt, that is, from the ſmalleſt degree of the Motion and Heat of Fire which melts the ſolid Quickſilver, even to the greateſt imaginable, namely, that ſurpriſing degree of Motion and Heat which is produced at the Focus of Villette's Mirrour."

" *N. B.* This muſt be a more intelligible way of arguing, than that of *Heat* and *Cold*; for as it is allowed that Heat is only relative, that is, the Heat which is leſs than that of the human Body, we term *cold*, and that which exceeds ſuch Heat, we call *hot*; Heat and Cold therefore cannot be ſo juſt a diſtinction as to term them different degrees of *Heat*; becauſe it is not a little difficult to know where to place the Zero (or 0) on the Thermometer, to point out where the Cold begins. If this Diſtinction be diſliked on account of the manner of defining it, the World will be much indebted to any one, who can ſhew where to fix the ſtandard on the Thermometer that will ſhew where the Cold ends, and the Heat begins. ——— Hence appears the neceſſity of making choice of the moſt adequate Terms."

The foregoing Obſervations being duly conſider'd, it evidently appears that Fire is never totally deſtitute of Heat, nor conſequently of Motion, from the greateſt degree to the leaſt: And if we uſe the ſame Author's Term, Cold, inſtead of leſs degree of Heat, then we may ſay, that Fire in the greateſt artificial *Cold* that is poſſible, is agitated 65 degrees and a half more than it is in the forementiond artificial one of 40 degrees, i. e. 105 degrees and a half; from which greateſt degree of Cold, through every intermediate degree, it is continually diſſolving ſome Bodies which a little before, in a ſmaller degree of Heat appear'd of a ſolid Conſiſtence. Fire therefore is perpetually agitated in the greateſt Cold, and ſtill gradually more and more in every increaſe of Heat, and conſequently is always hot and in motion.

By the help of this Recapitulation I hope I have ſo fully declared my ſentiments on Fire, and the cauſe of Heat, that no one will have the leaſt room to think that I ever was ſo inconſiſtent with myſelf, as even to inſinuate that I ſuppos'd there was no Heat in Fire.

" The Analogy or degree of proportion between the Elaſticity and Rarity of the common Air, and the ſame Properties in Æther, was according to Sir *Iſaac Newton* as 700000 to 1."

It

(*a*) It was this remarkable difference of thoſe inherent Properties, which was the cauſe of my making a more peculiarly ſtrict ſcrutiny into it, than I ſhould otherwiſe have done."

* * *

DIALOGUE II.

Electrical Fluid, true and real Fire; indefinitely elaſtic and rare; acts by Preſſure or an impelling Force; the Author charg'd with deifying it; delegated by the wiſe Author of Nature.

B. WHAT elſe is neceſſary to be known before the Experiments can be ſatisfactorily explain'd, and the Electrical Fire render'd intelligible?

A. One thing more is altogether as neceſſary as the former, *viz.* that which Sir *Iſaac Newton* hinted at in the concluding paragraph of his Principia, namely, "now we might add," he ſays, "ſomething concerning a certain moſt "ſubtile Spirit, which pervades and lies hid in

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(*a*) For Sir Iſaac's Computation and the manner of Inveſtigation, See his Optics, Quære 21ſt, or Eſſays, p. 68.

"all

[illegible] exp

16 [illegible] both

ele

1719 every thing

20

21

" all groſs Bodies, *&c.*" which altho' but a mere hint, (*a*) was diſcover'd when examin'd by electrical Experiments to be juſt: Nothing is more clear and obvious, than that we obtained the ſame Spirit from the Pores of all contiguous non-electric Bodies. But more of this hereafter.

Theſe Diſcoveries of that great Philoſopher of the remarkable Rarity and Elaſticity of Æther are abſolutely neceſſary to be known, before the Experiments can be rendered intelligible, or even reconcileable to one another; (*b*) which if duly attended to, will prove (as was obſerved in my Eſſays) a Key to ſolve and unlock moſt other Difficulties throughout all the Operations of Nature.

B. I muſt own that your Arguments ſeem ſo rational and perſuaſive, as to excite my Curioſity to become better acquainted with this amazing Power of Nature, ſince you aſſure me the thing is not ſo very difficult as I imagined, and particularly, if it be examined with attention and impartiality. In order therefore to do it the more effectually I will undertake the peruſal of your Eſſays again; for altho' I read them once, I muſt confeſs I did not much conſider the true purport of them, and as at the ſame time I thought the Subject too difficult

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(*a*) This I call a mere Hint, becauſe nothing relating to the ſame Subject occurs in all his Principia, but in that portentous Paragraph only with which he concludes it.

(*b*) This has been thoroughly conſidered by electrical Philoſophers.

cult ever to be underſtood, probably that was the Reaſon of my Reading them over too curſorily.

A. Before you begin the Book again, it will be neceſſary to inform you, that the electrical Fluid is in form of an extremely elaſtic Air, and, as you will find, indubitably proved to be true and real Fire, and withal as pure as the Solar Fire in the Focus of a burning Glaſs, ſince like that it yields neither Smoke, Aſhes, nor any other groſs Matter.

And here I muſt previouſly obſerve to you, that this is what the Antients and ſome few of the more diſcerning Moderns have termed elementary Fire; how they diſcovered that ſuch a Principle exiſted, and particularly that it was Fire is not eaſy to conceive; and notwithſtanding this their Deſcription of it was juſt what we find it to be, ſince we have made ſo complete a Diſcovery of it, as even to realize it to the Senſes.—You will likewiſe find that it appears to be an univerſal Agent in the ſtricteſt Senſe, ſo as to occupy and fill all Space, not only all free and open Spaces, but the *minuteſt Vacuities and Interſtices or Pores of the moſt compact and ſolid Bodies*, agreeable to the Prediction of Sir *Iſaac Newton* as we find in the concluding Paragraph of his Principia, as hinted above, and as will more fully appear from Experiments in various Parts of the Eſſays, particularly at Pages 37, 38, 39, 40, *&c.*

B. What do you really believe might be ſafely concluded concerning its Nature, Office, and general Uſe?

A. Were I to declare my own private Sentiments to you, I ſhould affirm, without any heſitation, that this grand Principle is the primary or firſt, and indeed, ſole Cauſe of all other ſecondary Cauſes whatſoever. —— That it is indefinitely elaſtic, and acts by preſſure or an impelling force; the mechanical Cauſe that we breathe, live, and move; the efficient Cauſe of all Motion; the phyſical Cauſe of Gravitation, Coheſion, Magnetiſm, the ebbing and flowing of the Sea, and of all other the moſt abſtruſe Phenomena of Nature.

B. Why, my Friend, you take moſt ample ſtrides indeed! I am afraid Electricity has turned your Head; ſince you go on thus, I muſt look upon you as a down-right Enthuſiaſt, and that you are abſolutely electrically mad.

A. You may, Sir, rally and banter me as you pleaſe, and think that I have taken unwarrantable ſteps; but I am perſuaded you will find that I am not the only perſon who has affirmed very great things of this univerſal powerful Principle, which Electricity has diſcovered to us. As firſt, Dr. *Franklin* has undeniably proved by his Experiments, that the electrical Fluid and the Fire of Lightning are indubitably the ſame, affirming that the greateſt known Effects of Lightning may be exceeded by it. Secondly, we are informed by the learned

Dr. *Prieſtly*, in his Hiſtory of Electricity, that it is the general opinion of the moſt learned Electricians, that the Aurora Borealis, Falling Stars, all Meteors in the Air, Water-Spouts, *&c*, at Sea, Whirlwinds and Hurricanes by Land, and even Earthquakes, are electrical Phenomena: This is the clear opinion of Dr. *Stukeley*, whoſe ingenious Papers on the ſame ſubject were read and approved by the Royal Society (*a*). The moſt judicious and juſtly admired Author the Rev. Mr. *Jones*, another ingenious Electrician, after ſpeaking of Electricity, proceeds yet farther, and affirms there is hardly a motion in nature which this "Fluid, "when applied by a diligent Experimentaliſt, "is not capable of producing —It will give a "rectilinear motion in all directions; will pro-"duce the motions of Rotation and Revolution; "it will keep a Body ſuſpended at a certain "diſtance in the Air without any viſible cauſe "and make it turn ſwiftly on its Axis; it acce-"lerates Vegetation, increaſes the motion of "Blood in the Arteries, raiſes Water into "Tides, and, in a word, will ſhew itſelf as a "natural Inſtrument to be little leſs than *All-"Sufficient* (*b*).

B. All-Sufficient! Why then I find Electricians don't ſtick at *deifying* it; ſince you affirm it ſo Univerſal as to be preſent in all places,

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(*a*) See Dr. Prieſtly's Hiſtory of Electricity, p. 381.

(*b*) Rev. Mr. Jones on the firſt Principles of Natural Philoſophy, p. 26, or in the Eſſays, p. 402.

and in the pores of all Bodies, which is affirming it to be *Omnipreſent*; and if this be not deifying it, I am at a Loſs to know what is ſo.

A. Whatever you may think, I have affirmed no more concerning its Univerſality, Nature, Office, and ſeveral Uſes, than what appears not only probable, but what has been confirmed by undeniable Evidence and actual Experience, as all ſincere unprejudiced Enquirers after Truth, who are converſant with electrical Experiments, are thoroughly convinced of; for which, and other like Reaſons, it is my humble Opinion that it ought to be eſteemed as *ſacred*, i. e. delegated by the wiſe Author of Nature to be the principal, if not the only Inſtrument which he has appointed, and makes uſe of to execute his Divine Will throughout the mundane Syſtem. I am therefore ſo far from retracting what I have affirmed of it, that I am fully convinced I do not overrate its Excellence in calling it an univerſal, mechanical Inſtrument of Nature; nor will you find when you read over my Eſſays with attention, that I have exaggerated or gone beyond what is there proved by the moſt convincing Experiments.

B. I think you are rather poſitive in your Aſſertions, but as you aver that they are founded upon the moſt unexceptionable Experiments, I ſhall think myſelf greatly obliged to you for your further Obſervations on this important Subject.

A. If you will only hear me with Impartiality and Attention, I am perſuaded I ſhall be able to make you a Convert to Truth.

DIALOGUE. III.

The Neceſſity of Recapitulations.----An Inveſtigation of the extreme Elaſticity and Rarity of Æther.---Contradictory Principles of the current Philoſophy.----Neceſſity of explaining Terms.---Gravity and Attraction made uſe of in one and the ſame Senſe.

A. I Have had many thoughts concerning our laſt Converſation, and do not much wonder that you, who have not been converſant with electrical Experiments, ſhould think me ſanguine and poſitive in my Aſſertions, but cannot help admiring at the ſame Time that amongſt ſo many learned Electricians, and ſuch as profeſs themſelves Newtonians; few, if any, have applied the ſubtile Medium to the Explication of the Phenomena of Nature.

—Sir *Iſaac Newton* was of Opinion, that a ſubtile Medium not only exiſted, but alſo that *it was the Phyſical Cauſe of all the capital Phenomena in the Univerſe:* Whereas we, that have made a compleat Diſcovery of it, ſeem to look upon the Sentiments of ſo great a Man, as unworthy our Cultivation and Attention. And, even you yourſelf, had you read my Eſſays with care, might have been able to judge for yourſelf of theſe Matters.—There you would have ſeen how cautious I was, and the Care I took that I might impoſe neither on myſelf nor others

When I firſt began my Enquiries, finding that Air was a principal Agent in producing ſuch wonderful Effects in Electricity, I was lead to enquire more particularly into the Nature, Properties and conſtituent Parts of the Atmoſphere, accordingly I conſulted the moſt authentic Writers on that Subject, and particularly the learned Biſhop Berkeley, who had beſtowed much Time and Pains on it, and adopted many of the Opinions of the Antients concerning Air (*a*). After purſuing ſuch Enquiries, I diſcovered that the Electrical Fire itſelf was only a more pure and exquiſitely elaſtic Air: I was therefore convinced that I could not fix my Firſt Principles on any Baſis ſo firm as on Air, which are, as you will find, in the Eſſays, Page 22, Sect. 50.

(*a*) Eſſays, Page 9, Section 31.

From p. 33 to p. 37. are Lord Bacon's and Sir Iſaac Newton's Sentiments concerning a ſubtile Æther or Spirit in the pores of bodies: From thence to p. 40. Section 83. are Experiments to prove the ſame, and to ſhew by what means it is retained there.

Page 41. Section 85. ſhews how it was condenſed and retained in open Air.

Page 54. Section 116. ſhews that the particles of elaſtic Fluids mutually repel and recede from each other, proved by various Experiments.

Page 67. Section 141. Sir Iſaac Newton's inveſtigation of a method to prove the extreme Elaſticity and Rarity of his ſubtile Medium or Æther, with a variety of others.

B. This method of Inſtruction might be very good, if my Head, like a common Place-book, could retain every thing that was committed to it; but as that is not the caſe, I muſt beg you to be ſomewhat more explicit, and make Recapitulations wherever they may ſeem moſt requiſite, otherwiſe a great part of your trouble will be thrown away; that is, if you do not repeat the whole Paſſage where ſuch Repetitions are neceſſary.

A. I cannot but own that your obſervation is juſt, and that mere references might not be always ſufficient; I will therefore, according to your deſire, be more particular, eſpecially as you ſeem determined to purſue the ſubject in good earneſt. Beſides ſhould I ever have a mind to publiſh this Conference, thoſe Readers who have never ſeen the Eſſays, will be as well pleaſed with the Recapitulations as you; And though ſome might cenſure them as ſuperfluous, they may eaſily paſs over them; and I am convinced that in a Performance of this kind ſuch Repetitions cannot well be avoided, except we chooſe to ſacrifice perſpicuity to conciſeneſs.

B. I muſt now beg you to inform me what are the moſt eſſential Properties of this ſubtile elaſtic Medium?

A. An almoſt inconceivably great Elaſticity, and yet as extreme a Rarity or Fineſs as before mentioned. However, it muſt be owned that we are highly indebted to Sir Iſaac Newton for pointing them out. For had it not been for his aſſiſtance, we might have been ſtill, and probably a much longer time, groping as it were in the dark after them, and perhaps never have been able to anſwer that Queſtion ſatisfactorily.

When deſcribing his ſubtile Medium or Æther, he informs us that it is 700000 times more elaſtic than the Air, and above 700000 times more rare. Query 21ſt.—But although ſuch a ſubtile Medium, as Sir Iſaac then conjectured to exiſt, is now actually diſcovered by the cleareſt Experiments, and even realized to the Senſes, and which we find to be poſſeſt of thoſe remarkable Properties which are above mentioned in a ſurpriſing degree; yet, we were not aware, nor could ever have imagined, that the proportion of thoſe natural properties or qualities in the Æther, and the ſame properties in common Air was ſo great as 700000 to 1, had we not been thoroughly convinced by Experiment of its extremely great Elaſticity and Rarity.

In the next Query he ſays, if this Æther be ſuppoſed 700000 times more elaſtic, and above 700000 times more rare, its Reſiſtance would be above 600000000 times leſs than that of Water, and ſo ſmall a Reſiſtance would ſcarce make any ſenſible alteration in the motion of the Planets in 10000 Years. — Here Sir Iſaac ſeemed to doubt whether ſo great a Rarity would be credited; therefore to obviate ſuch an objection he ſeems to demand an anſwer to another Queſtion, ſaying, if any one ſhould aſk how a Medium can be ſo rare, let him tell me how the Air in the upper parts of our Atmoſphere, can be above a hundred thouſand thouſand times rarer than Gold?

Before the real diſcovery of ſuch a ſubtile Medium by means of the electrical Apparatus, the very exiſtence of any ſubtile Medium, beſides that of common Air, was denied and rejected with a ſovereign contempt, and is ſtill diſbelieved by very many, notwithſtanding it is moſt clearly verified by Experiments even to our bodily Senſes.

Hence the invincible power of Prejudice in favour of preconceived Opinions, inſomuch as to deny the plaineſt Facts. Thoſe two inherent Properties appear in the electrical Fluid in a moſt wonderful Degree, though the exact Proportion to the ſame Properties in common Air is not eaſy to aſcertain; But by Means of theſe two Properties in the electrical Æther, together with what was before hinted of its lying hid in all groſs Bodies, the Experiments are ſolved in a rational Manner, which would otherwiſe be abſolutely impoſſible.

Of all the great Diſcoveries made by Sir *Iſaac Newton*, thoſe of the extreme Elaſticity and Rarity of Æther will be found to be by no Means the leaſt, notwithſtanding there hath hitherto been very little Notice taken of them: However, I am confident they will be found abſolutely neceſſary before any conſiderable Advances can be made towards explaining the Experiments. See the Inveſtigation of thoſe inherent Properties, Optics, Query 21ſt, or in the Eſſays page 68, Section 142.

But as neither of them may be ready at hand, I ſhall, for the Information of my new Subſcribers, repeat the Inveſtigation, and the rather, ſince ſome other Things may by that Means be rendered more clear.

Firſt, That the Medium which propagates Sound is the common Air or Atmoſphere; and that the Æther beyond the Atmoſphere is the Medium which propagates Light from the Sun. He then conſiders the different Velocities of Light and Sound, and obſerves, *Secondly*, that

Sound moves no more than the ſpace of 100 Miles in much about the ſame ſpace of time that Light moves from the Sun to the Earth, which diſtance Sir *Iſaac* computed at 70 Millions of Miles; ſo that the former is contained in the latter 700000 times (*a*). This Datum, ſlender as it may ſeem, was yet ſufficient for his Inveſtigation of the Proportion of that remarkable Inequality, or Difference, of the Elaſticity and Rarity of the ſubtile elaſtic Medium of Æther, and the ſame Qualities in the elaſtic Air (*b*); the following are his own Words.

“ Sounds move about 1140 Engliſh Feet
“ in a ſecond Minute of Time; and in 7 or 8
“ Minutes of Time, they move about 100
“ Engliſh Miles. Light moves from the Sun
“ to us in about 7 or 8 minutes of time, which
“ is about 70,000000 Engliſh miles; ſuppoſing
“ the horizontal Parallax of the Sun to be
“ about 12″, and the Vibrations or Pulſes of
“ this Medium, that they may cauſe the al-
“ ternate Fits of eaſy Tranſmiſſion and eaſy
“ Reflection, muſt be ſwifter, and by Con-
“ ſequence above 700000 Times ſwifter than
“ Sounds, and therefore the elaſtic force of this
“ Medium in Proportion to its Denſity, muſt
“ be above 700000 multiplied by 700000 (*c*),
“ that is, above 490000,000000 Times greater
“ than the elaſtic Force of the Air is in Pro-

(*a*) As 100 : 1 :: 70 000000 : 700000; or as 700000 : 1 :: 70,000000 : 100.

(*b*) i. e. The Atmoſphere.

(*c*) i. e. 1 : 700000 :: 700000 : 490000,000000.

" portion to its Denſity (*a*); for the Velocity " of the Pulſes of elaſtic Mediums are in ſub- " duplicate Ratio of the Elaſticities and the " Rarities of the Mediums taken together."

B. I do not underſtand Sir *Iſaac*, ſince he makes uſe of the Words Denſity and Rarity promiſcuouſly, as if they were ſimilar, notwithſtanding they are oppoſite Terms.

A. If you conſider the Purport of his Reaſoning, you will find that the above mentioned Denſity is ſo extremely ſmall, that it is in reality, Rarity; the greatneſs of the Rarity and the ſmallneſs of the Denſity being the ſame Thing, and Sir *Iſaac* himſelf in the next Words calls it Rarity.

B. I ſhould be glad to be informed concerning the expanding Force of an elaſtic Fluid, I cannot poſſibly form any adequate Idea of the Nature of it. What can be the Mechanical Cauſe of ſuch an expanding Force, and what

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(*a*) Sir Iſaac Newton by allowing the Sun's Parallax to be 12" made the Diſtance to be about 70,000000 of Miles; whereas, according to later and repeated Obſervations made with the moſt accurate aſtronomical Inſtruments, the Sun's horizontal Parallax is not much more than 8 Seconds and an Half, whence the Diſtance of the Sun from the Earth cannot be leſs than 95,000000 Engliſh Miles, and if to avoid Fractions, we are allowed to call it in round Numbers, 100,000000, then, by Analogy, the elaſtic Force of this Medium in Proportion to its Denſity muſt be, according to Sir Iſaac's Method of Inveſtigation, above 1,000000 multiplied by 1,000000, i. e. above a Million of Million Times greater than the elaſtic Force of the Air is in Proportion to its Denſity, conſequently we may be allowed to call it an indefinite Number of Times more rare and more elaſtic than the common Air.

can be the form of the primitive Particles that conſtitute ſuch a Fluid?

A, This is not eaſy to aſcertain: Mr. *Boyle* was of Opinion that the primary Particles of ſuch a Fluid, fine as they are and imperceptible to the Senſe, muſt be in Form like ſo many little Watch-ſprings, coiled and contorted in the Nature of Spirals, but infinitely more perfect, ſince theſe act every way, and every way alike in a ſpherical Manner.

B. But if this ſpiral-like Form of the Air be neceſſary to cauſe the Elaſticity of it, we muſt be allowed to ſuppoſe the ſame Spirals in Water, though an incompreſſible Fluid. The Steam of boiling Water appears by its Effects to be equally elaſtic with the Air. Water incloſed would, if ſufficiently heated, burſt the ſtrongeſt Veſſel. In the Æolipile its Elaſticity is as manifeſt as that of the Air. Are the Particles of Water then of a ſpiral-like Form, and is the Suppoſition neceſſary?

If it is not neceſſary to account for the Elaſticity of Water, it cannot be ſo to account for that of the Air. It would be abſurd to feign a ſet of ſpringy Particles in Water.

A You ſeem to have forgotten what Electricity has rendered moſt clear, *viz.* that the Pores of all groſs Bodies are replete with electrical Fire which is only a more pure Air, and is always expanded by heat. Steam is a compoſition conſiſting of the primary Air, Æther, or true Fire, blended with the Particles of

Water. This Fire in the Steam, is as elaſtic in the Æolipile, *&c.* as in the common Air; but the Elaſticity of the Steam is by no Means the Effect of the watery Particles, but of that of the Fire in the Pores of the Water (*a*).

B. Before we proceed any further you muſt give me leave to tell you that your philoſophical Principles ſeem to me ſo very heterodox, that I cannot call you a Newtonian; I ſhould therefore be glad to know what to ſtile you as a Philoſopher; ſhall I call you a Hutchinſonian?

A. I was ever a profeſſed Enemy to Parties of all Denominations, (at leaſt, ever ſince I was capable of judging) on account of the Heat and Animoſities ſubſiſting amongſt them, and the illiberal Names they ſo frequently beſtow on one another, even to the Scandal of all Parties, and therefore cannot help having an utter Averſion to Parties in Philoſophy, as well as in Theology.

And as to the Hutchinſonians I never ſaw any of their Writings, and am conſequently a Stranger to their Principles; though, were I to diſtinguiſh myſelf as a Partiſan, I ſhould ſtile myſelf an *Electrical Philoſopher*; for it is to Electricity alone that I am indebted for that ſmall Stock of Knowledge, which I have acquired in my Reſearches of Nature

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(*a*) Let it not be ſaid this is like begging the Queſtion, and taking for granted the very Thing which wants to be proved, for it has been proved again and again, and is obvious to every one who will but make almoſt any electrical Experiments with Attention.

Before the late great Improvements that have been made in Electricity, I had no Thoughts of ever commencing Philoſopher. — Becauſe the Books that treated of Natural Philoſophy, and undertook to explain it, were for the moſt part obſcure and perplexing, or elſe the Rules implied manifeſt Contradictions; for example, if I had a Rule or Maxim laid down to obſerve that all Matter was inert, having no Affections or Properties peculiar to it as Matter, but was intirely inactive and dead; I ſhould have another, or perhaps two, that contradicted it; or, which is the ſame thing, ſome of the moſt active Properties were aſcribed to it, ſuch as Attraction and Impulſe; *i. e.* Matter or Body in ſome Circumſtances was indued with a mutual Attraction, in others with a repelling Force, both which active Properties were ſeated in the Bodies themſelves.

Another Poſition was, that where Attraction ends a repelling Force begins; with other arbitrary Maxims, which never were, or can be proved or reconciled.

Moreover when I came to look into Sir Iſaac Newton's Principia, I had not read through his Preface, before I found that great Man himſelf complaining much of the many Ambiguities to be met with in Philoſophy. — This, and the above mentioned Contradictions and Difficulties being laid together and conſidered, I muſt own I had no great Inclination to attempt what Sir Iſaac called the *Search of*

Nature, being much more inclined to Mathematical Studies; 'till of a ſudden, a Flood of Light broke in upon us by means of the accidental Diſcovery of the Leyden Experiment, which cleared away the Miſt, and effectually convinced us that all Matter was not, according to the received Maxim, *inactive*; but that there were *active* Particles likewiſe contained in it.

We then alſo found that inſtead of an univerſal Vacuum or Emptineſs throughout the whole Syſtem of Nature, which was before, a firſt and fundamental Principle; we had the greateſt reaſon to believe the contrary, and that all Nature was replete with an elaſtic aërial Spirit, or elementary Fire; and that the Want of that Knowledge left an opening for all thoſe Difficulties and Contradictions above mentioned: There then began to dawn, as it were, ſomewhat like an electrical, *i. e.* a rational Philoſophy.——Inſtead of ſuch an inconceivable mutual Attraction ſeated in the Bodies themſelves, to cauſe them to tend towards each other, that Phenomenon or Tendency appeared to be the Effect of the expanding Force of the univerſal Fire juſt then diſcovered; and inſtead of ſuch an unaccountable Attraction ſeated within the Bodies, the efficient Cauſe of the gravitating Tendency of them appeared to be extraneous, *i. e.* a *Cauſe* behind or beyond the Bodies impelling them, and cauſing them to tend.

A certain Author obſerves, " That the " Spirit of Diſputing, and an earneſt Deſire " to obtain the Victory rather than come at " the Truth, has been one of the greateſt " impediments to the improvement of natural " Knowledge. And that nothing occaſions " more Wrangling, than when different Per- " ſons annex different Ideas to the ſame " Words; for Men can never rightly under- " ſtand one another, till they mean the ſame " Things by the ſame Expreſſions. That no " Diſputes ariſe in pure Mathematics, becauſe " the Definition of the Terms are premiſed, " and every body that reads a Propoſition has " the ſame Idea of every Part of it."

" So that when any Man is ſo weak as to " think to bring one Demonſtration in Oppo- " ſition to another, he is to be diſregarded by " every one that would reaſon like a Philoſo- " pher; for we may immediately put an end " to all Mathematical Controverſies, by ſhew- " ing either that our Adverſary has not ſtuck " to his Definitions, or has not laid down true " Premiſes, or elſe that he has drawn falſe " Concluſions from the Principles he has laid " down; or at leaſt we muſt own that we do " not underſtand ſome Part of his Demonſtra- " tion, and deſire him to explain it; for unleſs " we can ſhew where the Error or Paralogiſm " is, we muſt not condemn by the Lump, " but acquieſce with him in what he has " proved."

'Tis indeed moſt certain that the neglecting to explain Terms has been the Cauſe, not only of ſome of the greateſt and warmeſt Diſputes among Authors in general, but has alſo been productive of ſome of the worſt Effects; for had Terms been explained, it had been next to impoſſible, that ſuch palpable Contradictions ſhould ever have been introduced into Science itſelf, as they moſt evidently have, particularly thoſe of Attraction and Gravity.

Were Terms explained, no one would heſitate concerning the meaning of the Word Attraction, or the drawing of one thing towards another; the ſame may be affirmed of the meaning of the word Gravity, or Weight. But if any one, engaged in a Diſpute, were to take the Liberty of uſing the Terms promiſcuouſly, ſo as to mean either *Drawing or Weighing*, which he pleaſed, he by means of ſuch an Artifice would have it in his Power to play ſo faſt and looſe, that there would be no arguing with him.

Electrical Philoſophers ſeem juſtly to wonder that it could ever enter into the Minds of Men to interpret theſe two Words (which are ſo widely different in their Signification from each other, as thoſe of Gravity and Attraction manifeſtly are) ſo as to have any Similarity or Likeneſs at all, and much leſs that they ſhould mean one and the ſame thing. Does not Dr. Friend argue much more conſiſtently, who affirms, that Attraction is the Cauſe, and

Gravity the Effect? Have not Gravity and Attraction the ſame Relation to each other as any Effect and its Cauſe? With what Propriety then can they be deemed one and the ſame thing? Can it be thought any great Matter of Surprize, that a Philoſophy thus circumſtanced ſhould be embarraſſed with ſuch inſuperable Difficulties and Perplexities, as could never have happened, had Terms been previouſly explained?

In a Word—a Neglect of explaining Terms ſeems to be one of the greateſt, if not the principal Reaſon of the many Perplexities and Ambiguities in the current Philoſophy, as it left room, at leaſt, for the introducing various Inconſiſtencies.

Dr. Derham, though allowed to be an undiſguiſed Author, ſeems to beſpeak, as it were, the promiſcuous Uſe of theſe two Terms in ſtead of one, although quite different in their Senſe and Meaning. In his Aſtro-Theology—Book 6. p. 137.—he undertakes to ſhew the great Uſefulneſs of Attraction, but begins it with enquiring about Attraction *or Gravity*, as if both of them in Conjunction had been allowed to be one and the ſame Principle. But ſurely theſe are ſuch Liberties which can never be thought conſiſtent with ſound Reaſoning.

Moſt certainly a Philoſophy, embarraſſed with ſo remarkable Difficulties as to require the Aſſiſtance that ſuch miſerable Auxiliaries are capable of affording it, can never be founded on rational and true Principles; and yet at the ſame Time boaſting of it as a Philoſophy that hath already arrived at the Summit of Perfection.

How juſtly, I ſay, might we exclaim againſt a Philoſopy, which affirmed that all Matter was inert, and yet in the next Breath aſcribe to it the moſt active Properties, as Attraction in particular. Although no Word can be more expreſſive of its Senſe, or carry its own Meaning along with it to ſignify a *Cauſe* or *active Principle* plainer than that does, yet it is immediately turned into an Effect; and Gravity, Coheſion, Magnetiſm, *&c.* all of them into *Cauſes*; as when we ſay, Attraction of *Gravity*, Attraction of *Coheſion*, Attraction of *Magnetiſm*, *&c.* *&c.* That Effects are frequently put in the Place of Cauſes is notorious, and even *Motion* is often made to ſignify a *Principle* or *Cauſe*.

To prove this to be Fact, ſee p. 242 of the Eſſays, where you will meet with an extraordinary pompous Harangue on Motion, as a *Cauſe*, by Dr. Stephenſon, Author of the Mechanical Phyſician. I ſhall at preſent only cite a few Lines at the Beginning of it, which may ſerve as a Specimen of the reſt.

“ Among ſecond Cauſes, Motion is the
“ principal immediate *Agent* and *Inſtrument*
“ of all the Effects, Operations, and Phe-
“ nomena that are produced in the material

" Univerſe, and is the primary *Cauſe* upon " which the *Power*, *Force*, and *Energy* of " every Body, or Syſtem of Bodies, wholly " depend, *&c.* *&c.* (*a*)."

B. How do electrical Philoſophers avoid the like Abſurdies?

A. There can be no other effectual Way, than by explaining Terms with Preciſion, and having always a ſtrict Regard to the Definitions, in order to guard againſt either Miſtake or Deſign.

B. Why do you affect to make ſo many Quotations and Tranſcripts from other Authors?

A You miſtake, it is not Affectation: But as I never pretended to be learned myſelf, I am ſenſible that whatever I advance, be it ever ſo worthy of Notice, will be but coldly received, and that merely on Account of my Want of what is called *Learning:* My Reaſon therefore for ſo many Quotations is, that what I advance may have the Sanction of the more learned, particularly, when they are found to agree with and confirm my Reaſoning.——— *This I ſhall take for granted to be ſufficient to ſatisfy the judicious and candid Enquirer.*

(*a*) See Dr. Stephenſon's Aſſertion on Motion as a Cauſe, in Eſſays, Page 242. Section 152.

DIALOGUE. IV.

Tenets of electrical Philoſophers.---Advantages they are poſſeſſed of beyond others.--- Dr. Clarke*'s Diſpute with Monſr.* Leibnitz.*--- Fire, the grand Deſideratum, being diſcovered, our Reaſoning is now* a priori.*---Concerning mechanical Agency.--- Lord* Bacon *on the ſame.--Reaſon for prefixing ſo humble a Motto to the Eſſays.--- Fire, but one kind of it, and what that is.*

B. WHAT do you mean by an Electrical Philoſopher?

A. By an Electrical Philoſopher, I mean, one who is become a Philoſoper, merely from the Knowledge acquired by electrical Experiments: And by Electrical Philoſophy, I mean, a Philoſophy founded on electrical Principles.

B. What are the Tenets which are maintained by electrical Philoſophers?

A. "That the Frame of Nature is a perfect "and well ordered Machine; or in other words, "that the viſible Syſtem of the World was "created, diſpoſed, and ſet into Motion by

" the Finger of God; acts as a Machine does,
" a Connexion and Communication being
" preſerved between all the diſtant Parts of it;
" for if the Contact of a Machine be interrupted,
" the Motion is deſtroyed in all thoſe Parts
" from which the Communication is cut off.
" More particularly, ſuch Philoſophers aſſert,
" that the fluid ætherial Matter of the Heavens
" acts by Impulſe on the ſolid Matter of the
" Earth; is inſtrumental in every one of its
" Productions, and neceſſary to all the ſtated
" Phenomena of Nature."

" Hence they divide the Elements into
" active and paſſive; not that they are ſuch by
" any inherent or eſſential Difference; but that
" according to the Order eſtabliſhed by the
" Divine Architect, they are obſerved to ſub-
" ſiſt under theſe different Relations."

B. What Emoluments are electrical Philoſophers poſſeſſed of beyond others, which they were Strangers to before?

A. Many, and very remarkable ones, ſome of which I ſhall mention:

Firſt, Fire in particular, which one ſhould naturally imagine to be one of the moſt familiar Subjects, yet, before it was illuminated by Experiments made in Electricity, there are few Things of any Conſequence of which we were much more ignorant. Before that time we knew ſo little of the Nature of Fire and Heat, that we imagined them to be one and the ſame; conſequently, as we were certain that Heat could be generated and deſtroyed at Pleaſure, it muſt have been a Contradiction to ſuppoſe that Fire was a permanent Principle.—— We had no Criterion, no infallible Mark or diſtinguiſhing Characteriſtic to point out to us that Fire was a more permanent Principle than Heat, till Electricity taught us to make a proper Diſtinction between them.

Secondly, Since Fire has been diſcovered to be a permanent Principle, we are enabled to give a rational Account of the Cauſe of Motion in the World, which is ſuch an Advantage we never before could arrive at.

Thirdly, Before that grand Deſideratum was diſcovered, we contented ourſelves, when treating of Gravitation, for example, with ſaying, ſuch and ſuch things were effected by Gravity; not conſidering that Gravity itſelf was only the Effect, and that conſequently theſe things were brought about by the *Cauſe* of Gravity: This being the Caſe, it could be no Wonder if Philoſophy was in a very perplexed State, eſpecially as we ſo confounded Terms, particularly thoſe of Gravity and Attraction. We adopted Attraction as a firſt Principle, and when we had it, knew not what to make of it; for although we adopted it as a firſt and fundamental Principle, yet at other Times we could allow it to be no more than a mere Phenomenon (*a*),

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(*a*) Dr. Samuel Clarke undertook to vindicate Attraction when attacked by Monſieur Leibnitz and others, and replied,——

However this was not our Fault, but rather our Misfortune, ſince it was owing to the imperfect State Philoſophy was then in.

Fourthly, Another Advantage which we poſſeſs beyond others is, that whereas none before the Diſcoveries that have been made by means of Electricity could poſſibly know any thing of the Nature of Fire, nor hardly what was meant by the Term Elementary Fire; Electricity has diſcovered and verified elementary Fire itſelf, and that in ſo plain a manner, as even to realize it to the Senſes, and at the ſame time we are aſſured it is in Form of a moſt exquiſitely fine pure Air or Æther.

While Men remained ſo entirely ignorant of Fire, as not to be able to know whether any ſuch Principle exiſted, it was impoſſible for them to know how to diſtinguiſh between Fire and Heat; they therefore concluded them to be the ſelf ſame thing, and finding, as before

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“ It is very unreaſonable to call Attraction a Miracle and an unphiloſophical Term, after it has been ſo often diſtinctly declared, that by that Term we do not mean to expreſs *the Cauſe of Bodies tending towards each other*; but barely the Effect of this Cauſe, or the *Phenomenon itſelf*, diſcovered by Experience, whatever be or be not the Cauſe of it. Gravitation or Attraction *in this Senſe* (he adds) is an actual Phenomenon of Nature.”——And again; “ Philoſophers therefore may ſearch after and diſcover that Cauſe if they can, be it Mechanical or not Mechanical; but if they cannot diſcover the Cauſe, is therefore the Effect itſelf, the *Phenomenon*, or the *Matter of Fact diſcovered by Experience* (which is all that is meant by Attraction and Gravitation) ever the leſs true?”

hinted, that Heat could be generated and deſtroyed at pleaſure, they for that Reaſon thought it a ſure Sign that Fire was not a durable Principle any more than Heat; and, what ſeemed moſt remarkable, no one could be much more miſtaken than Sir Iſaac Newton himſelf, as was manifeſt from his aſking if a red-hot Iron was not Fire?

Fifthly, Before the Diſcovery of Fire as a permanent Principle, we could never attempt to explain the Phenomena of Nature, otherwiſe than from firſt endeavouring to inveſtigate the Laws by which they acted.

We now, with much greater Readineſs, account not only for the Laws, but the *Cauſe*, of ſuch Phenomena, conſequently our Reaſoning is now *a priori*. Fire, the grand Deſideratum, being diſcovered, we can with equal Propriety proceed from the *Cauſe* to the *Effect*, which is ſuch an Advantage as was not attainable before.

Sixthly, Another Emolument, no leſs favourable and ſatisfactory than any of the reſt, is, that ſince the Diſcovery of an elementary Fire, a Variety of the moſt abſtruſe Phenomena of Nature, which were unaccountable before, are rendered clear and intelligible, and a general mechanical Agency appears more and more conſpicuous. —— The Rev. Mr. Jones obſerves, that " the Writings of our modern " Reaſoners, whether Metaphyſicians or Ma- " thematicians, are ſtored with Objections, "not only againſt the Reality, but even the Poſſibility of a *mechanical Agency* (*a*)." But however, the Light now reflected on the Works of Nature in general has left much leſs room for ſuch Objections.

To illuſtrate the Doctrine of a mechanical Agency, I ſhall quote a Paſſage out of the above-mentioned Book, which appears to put the Reality of a general Mechaniſm paſt diſpute.

"That God does," he ſays, "in many Caſes, govern the World by material Agents, and conſerve the Motion of Bodies by the Activity of ſecondary Cauſes is beyond diſpute. The ſupport of animal Life by Breath; the Motion of a Ship before the Wind; of the Sap in Vegetables at the Approach of the Sun's Light; of the Mercury in the Barometer by the Preſſure of the Air; of the Fluid in a Thermometer by the expanding Power of Fire; of Bodies impelled and driven off again by the Flux and Reflux of electrical Æther, with innumerable other Phenomena of Nature, all conſpire to eſtabliſh this plain Truth. And if it be an Axiom in Phyſics, that more Cauſes are not employed where fewer will ſuffice, how comes it to paſs that thoſe Agents, which confeſſedly miniſter to ſo many and great Effects, are not ſufficient for the producing

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(*a*) See Mr. Jones's firſt Principles of Natural Philoſophy, Page 10, or p. 272, of the Eſſays.

“ of all? Shall we allow that God governs the
“ World by a ſubordinate Agency and Mechaniſm
“ in ſome Caſes, where that Agency
“ appears to us, and deny it in others, merely
“ becauſe we have loſt ſight of it, or becauſe it
“ would make againſt us? A Philoſophy, that
“ labours under this Difficulty, and is one
“ while working with a material Cauſe, and
“ in the next breath with an immaterial one,
“ be it ever ſo ingeniouſly put together, will
“ after all be liable to this grand Exception;
“ at beſt, it is inconſiſtent and unworthy of
“ God. Every Body muſt ſee and know, that
“ there are material Cauſes acting in the World;
“ and he that denies it muſt deny his Senſes.
“ If theſe Cauſes are not ſufficient to perform
“ all the ſtated Operations of Nature, then the
“ Creator hath made uſe of ſuch Means as are
“ not proportionable to the End. If the
“ Creator himſelf performs them by the immediate
“ Agency of his own Subſtance, then
“ is there no need of any other Cauſes; they
“ are all ſuperfluous. But that there are other
“ Cauſes is abundantly evident; therefore they
“ muſt be capable of anſwering their end, and
“ every material Effect will be immediately
“ owing to a material Cauſe. What I here ſay
“ is grounded on this reaſonable Poſtulatum, if
“ it may not rather be called an Axiom, that
“ the Wiſdom of God is conſiſtent with itſelf
“ in its Operations; and that he wants neither
“ Power nor Skill to avoid the Error of Incon-

" ſiſtency: Grant but this, and the Argu-
" ment amounts to a Demonſtration." See his firſt Principles, p. 30.

I ſhall here juſt mention a Paſſage from Lord Bacon's Works, taken Notice of by the ſame Author.———See his firſt Principles, p. 220. " where he remarks, that there is not,
" in all the courſe of his Writings, ſo heavy a
" Cenſure, as that which he thought proper to
" paſs on thoſe who denied an univerſal Me-
" chaniſm in Nature."

" Certain it is," ſays that renowned Philoſopher, " that God worketh nothing in Nature,
" but by SECOND CAUSES: And if they
" would have it otherwiſe believed, it is mere
" Impoſture, as it were, in favour towards God,
" and nothing elſe, but to offer to the Author
" of Truth, the unclean Sacrifice of a Lye."

B. Have you any thing more to obſerve in general relating to this new-fangled Syſtem of Philoſophy.

A. Yes; that we, who are Profeſſors of it, are become Converts merely upon Conviction; for when we firſt began to ſcrutinize and examine the current Philoſophy, and had conſidered that its firſt Principles were an univerſal Vacuum, and an Attraction, whereas the electrical Fluid being ſo extremely elaſtic and ſubtile as to pervade all other Bodies, we naturally concluded, that inſtead of ſuch a Vacuum, there muſt neceſſarily be an univerſal Plenum, ſince a Fluid ſo extremely elaſtic, and yet ſo extremely rare, could never be at reſt till all Parts were equally full; and that conſequently hitherto we muſt have been wrong in almoſt every thing. We therefore judged it rational to make Trial of a different Syſtem, and found it upon Principles diametrically oppoſite to the former. This being put into execution ſucceeded according to our Expectations and Wiſhes, and I can with great Pleaſure and Truth aſſure you, that the more we purſue it, the more it ſeems ſtrengthened and confirmed; and although we have had ſome Years Trial of it, we never had the leaſt Reaſon to alter our Opinion concerning it. This gives us great Encouragement to believe that we have luckily purſued the Search of Nature, till we have diſcovered true Science, flowing, as it were, in its own native Channel.

What gives us the greateſt Reaſon to preſume that our Philoſophy is now flowing in the true Channel, is, that our Experiments are ſeldom or never obſerved to claſh with one another when explained on the above mentioned Principles, tho' ever ſo much varied and diverſified. —Nor is it one of the leaſt Advantages, that now a Man may become a very intelligible Philoſopher, without the Aſſiſtance either of much mathematical Learning, or of any other language than his own; conſequently the knowledge of Natural Philoſophy will now be a much eaſier Acquiſition than ever it was before.

B. How came you to think of prefixing ſo humble a Motto to your Eſſays?

A. I hardly know why I prefixed any at all, but only as a Motto was cuſtomary. However a principal Reaſon why I made Choice of one of that Kind was to intimate, that I conſidered myſelf as no way poſſeſſed of any extraordinary natural Talents; yet, that I thought myſelf certain I had ſtumbled on a true Method of philoſophizing, from the Light we received from the Diſcovery of electrical Fire, which Electricians of much ſuperior Parts and Learning had either heedleſly neglected, or elſe thought not worth their Notice.

Indeed, ever ſince the firſt Diſcovery of this wonderful Power of Nature, I have had as great a Propenſity, as others have ſhewn an Averſion, to cultivate an Enquiry into its Nature, Office, and Uſe.

What a Number of Experiments do we find in Dr. Prieſtly's copious Hiſtory of Electricity, and not one of thoſe Electricians make the leaſt Enquiry concerning the Uſes for which it was ordained: Thoſe they have made the Subject of their Enquiry appear merely trifling, when compared with thoſe relating to its Uſes.

It was thought ſomewhat remarkable, that Dr. Prieſtly himſelf, who had peruſed ſo great a Number of Authors on Electricity (as by his Catalogue we find he had) never once mentioned the Plan on which I proceed, notwithſtanding he inſerted my Eſſays in his Catalogue of Authors; juſt as if the Spirit of philoſophizing, lately ſo predominant, had all on a ſudden vaniſhed and forſaken Mankind.

B.

B. What do you take to be the Reaſon of that Diſinclination which is ſhewn to an Enquiry, which in your Opinion promiſes the moſt important Diſcoveries?

A. I can think of none, unleſs it be, that this electrical Fire, appearing with a Train of Tokens and Indications of Univerſality, ſhould diſconcert Philoſophers, by leaving no room for their adopted Vacuum; otherwiſe it was natural to expect, that Dr. Prieſtly would have ſaid whether my Enquiries into its Nature and Uſes were approved or diſapproved of.

B. I muſt further beg to be informed how to make a proper Diſtinction between the different Kinds of Fire; as elementary Fire, ſolar Fire, the Fire of Lightning, of Electricity, of culinary and ſubterraneous Fire; and in what reſpect elementary Fire differs from the reſt?

A. Electrical Philoſophers have but one kind of Fire, namely, the pure elementary Fire, the reſt being all different Modifications of the ſame homogeneous Fire, acting in different Conditions and Forms. The ſolar Fire is doubtleſs of the ſame elementary Kind; but we could not imagine there was any beſides ſo pure, till we were agreeably diſappointed by finding the electrical Fire to be ſuch, ſince that is ſo exceedingly pure, as, like the Rays of the Sun in the Focus of a Burning-glaſs or concave Speculum, to yield neither Smoke, Aſhes, or other groſs feculent Matter. To ſuppoſe more Kinds of Fire than one is deemed unphiloſophical, conſequently, even that which Dr. Prieſtly calls Natural Electricity, muſt be the ſame Fire in a different Dreſs: That I ſhall explain to you a little farther on, and ſhall give you the Doctor's own Account, from the 2d Edition of his copious Hiſtory. Period 10. Section 12.

DIALOGUE V.

Gravitating Tendency of Bodies accounted for, by the current Philoſophers.---Whether the whole Syſtem of Nature was created to be properly furniſhed, or to remain empty?---Whether the Gravitating Tendency of Bodies toward each other be the Effect of an exterior or interior Force?---Sir Iſaac Newton*'s Diffidence with regard to the Truth of his own Philoſophy.---Equal to the Geometrician, whether his firſt Principles are real or only imaginary.*

A. BEFORE I proceed farther, I beg to aſk *you* a Queſtion or two. How does the current Philoſophy account for that Gravitating Tendency which is ſo obvious among Bodies?

B. All Bodies, and all Matter, and Particles of Matter, have both an attracting and a repelling Property inherent in the Bodies themſelves; and where Attraction ends, a repelling Force begins.

A. As for Attraction, I muſt confeſs, I can form no tolerable Conception of it, and much leſs, that the ſame Matter ſhould both attract and repel, ſince two ſuch Principles in the ſame Body muſt deſtroy each other. Beſides, is it not an allowed Maxim in Philoſophy, that Matter is inert, having no Affections, Powers, or Properties? If then Matter be inactive and dead, how came Philoſophers to contradict their own received Poſitions ſo far as to aſcribe active Properties to inactive Matter? as Attraction, Repulſion, *&c.* Attraction of various Kinds, as Attraction of Gravity, Attraction of Coheſion, Attraction of Magnetiſm, electric Attraction, *&c.* *&c.*——The Sun attracts the Planets, and the Planets the Sun, and one another. By Attraction they account for the Tides, and moſt other difficult Phenomena. I deſire therefore to know how theſe Things are reconciled?

B. Your Queſtions ſeem ſomewhat captious; ſurely you think to ſap the very Foundation of the Newtonian Philoſophy; or at leaſt to give Occaſion of great Diſſentions among Philoſophers.

A. You never were more miſtaken in your Life; my ſole Intention is juſt the Reverſe. Electrical Philoſophy is altogether pacific, and tends to unite Philoſophers, and to put an end to their halting between two ſuch different and contradictory Opinions, as that of an abſolute Vacuum, and that of an univerſal Plenum of elementary Fire.

To prove which of us is in the right, let us put the Diſpute to the Teſt, by enquiring, firſt, Which appears the moſt rational Philoſophy; that which is founded on an univerſal Plenum, or one founded on an abſolute Vacuum; or in other Words, whether the whole Syſtem of the Univerſe was created to be properly furniſhed, or to remain empty for ever. — The Anſwer appears ſo obvious as ſcarce to admit of Heſitation. Secondly, Which ſeems the moſt reaſonable, to ſuppoſe that the Cauſe of Bodies tending or gravitating towards each other is a mutual attracting Force ſeated in the Bodies themſelves, or whether the Effect of an impelling extraneous Force, the Force of an univerſal elaſtic Medium behind or beyond the Bodies?

How the latter may be performed is obvious and clear enough to the Underſtanding of every one; but no one can form any rational Idea of the former. Even the greateſt Votaries for the Doctrine of Attraction, differ eſſentially themſelves about the Manner how it is performed; nor can they even ſo much as agree, whether it be a Cauſe or an Effect, as the Rev. Mr. Jones has indiſputably proved, in Book 2d. Chap. 2d. of his firſt Principles of Natural Philoſophy. See a Quotation of the ſame in the 8th Chap.

of the 3d Part of the Eſſays, p. 331. where it is diſcuſſed at large, the whole of which I ſhall not at preſent trouble you with, but ſhall juſt give a brief Summary, which Mr. Jones has drawn up, where he produces the ſeveral Authors giving their Verdict in their own Words. Eſſays, p 342.

Sir *Iſaac Newton* — " Gravity exiſts and " acts."

Dr. *Friend* — In explaining Gravity, ſays, " Newton has demonſtrated it to ariſe from an " attracting Force."

M. *Maupertius* — " It ſhould be remembered " in Juſtice to Sir Iſaac Newton, that he has " never conſidered Attraction as an Explana" tion of Gravity. He conſiders it not as a " *Cauſe* but an *Effect*."

Dr. *Cotes* — " Gravity is the moſt ſimple of " Cauſes."

Dr. *Clarke* — It has been diſtinctly declared, " that by the Term Attraction, we do not " mean to expreſs the Cauſe of Bodies tending " towards each other, but barely the Effect, " the Phenomena or Matter of Fact."

Dr. *Deſaguliers* — " Attraction ſeems to be " ſettled by the great Creator as the firſt of " ſecond Cauſes."

M. *Rowning* — " When we uſe the Term " Attraction, we do not determine the phyſical " Cauſe of it, but uſe it to ſignify an Effect; " nevertheleſs, to Attraction Effects are mani" feſtly owing."

Sir *Iſaac Newton*—"There are Agents in "nature able to make the Particles of Bodies "ſtick together by very ſtrong Attractions, "and it is the Buſineſs of experimental Phi- "loſophy to find them out."

Dr. *Deſaguliers*——"We are not ſolici- "tous about the *Cauſe* of Attraction."

Dr. *Friend*——"I believe Attraction "will always be occult."

"This is the Reſult of my Enquiry," ſays Mr Jones; "and if any perſon ſhould be ſo in- "clined, he is welcome to lay all the blame on "my want of Underſtanding. But if theſe "learned Men, who are all vindicating the "ſelf ſame Principles of Philoſophy, had no "clear Ideas of what they affirmed, and could "not underſtand one another, 'tis no wonder "if the World ſhould be at ſome Loſs to un- "derſtand them."

B. If there never was in Reality ſuch a Thing as Attraction, how came ſuch a Principle to be ſo generally received as it has been?

A. Attraction in Philoſophy, like Epicycles in the antient Aſtronomy, was a mere Invention to ſolve Appearances; nor had Attraction ever been thought of, could any other Expedient have been found to ſupply its place; for even when it was adopted by them, it would by no Means ſerve the Purpoſe they deſigned, unleſs they were ſometimes allowed to call it Gravity; that is, though it was received as a *Cauſe*, it would not ſerve the turn, unleſs it was alſo allowed, ſometimes to be explained, as an *Effect*.

Is it not ſtrange, as the Newtonians found themſelves ſo embarraſſed with inſuperable Difficulties relating to the Term *Attraction*, that at the Diſcovery of the electrical Fluid, (a Principle ſo powerful and extenſive as that appeared to be) they never attempted to examine it, ſo far at leaſt, as to try whether it was not capable of affording them ſome Aſſiſtance towards a truer Philoſophy than their own, or elſe to direct them to a Philoſophy, which was attended with fewer Difficulties than that which they were in Poſſeſſion of.

It would be natural to expect after ſuch a notable Diſcovery of ſo ſurpriſing and powerful a Force as the electrical Fire proves to be, that they would have ſet to work with one conſent, and cultivated the Diſcovery, in order to enquire whether it would not afford ſufficient light either to extricate them out of the inſuperable difficulties attending their Philoſophy, or elſe aſſiſt them in directing them to ſome truer Method of Philoſophy than what they had attained to before.

B. I never heard of any very remarkable Difficulties that attended the Newtonian Philoſophy, but the Reverſe; and that it is generally allowed, by Men of the beſt Underſtanding, to be the only true Syſtem that ever appeared in the World.

A. If Sir Iſaac Newton himſelf may be allowed to be a competent Judge, it is not a true

Syſtem of Philoſophy, and for this Reaſon, becauſe it is attended with the greateſt Difficulties. —Had he been certain that Philoſophy was fixed on a firm Baſis, he would never have publiſhed its Difficulties to the World in the Preface to his Principia, where he informs us, whence Difficulties in Philoſophy, in general, ariſe.

" All the Difficulty of Philoſophy," he ſays, " ſeems to conſiſt in this, from the Phenomena " of Motions to inveſtigate the Forces of Nature; and then from theſe Forces to demonſtrate the other Phenomena; and to this " end the general Propoſitions in the firſt and " ſecond Books are directed. In the third Book " we give an Example of this, in the Explication of the Syſtem of the World. For by the " Propoſitions mathematically demonſtrated in " the two firſt Books, we there derive from " the celeſtial Phenomena, the Forces of " Gravity with which Bodies tend to the Sun " and to the ſeveral Planets. Then from theſe " Forces by other Propoſitions, which are alſo " mathematical, we deduce the Motions of " the Planets and Comets, the Moon and the " Sea. I wiſh we could derive the reſt of the " Phenomena of Nature, by the ſame kind of " Reaſoning, from mechanical Principles. For " I am induced, by many Reaſons, to ſuſpect, " that they may all depend upon certain Forces, " by which the Particles of Bodies, by ſome " Cauſes hitherto *unknown*, are mutually impelled towards each other, or are repelled

" and recede from each other; which Forces " being unknown, Philoſophers have hitherto " attempted the Search of Nature in vain. " But I hope the Principles here laid down " will afford ſome Light, either to that or " ſome *truer* Method of Philoſophy."

Of this Complaint of Sir Iſaac, concerning the Difficulties attending the Search of Nature, *i. e.* of Natural Philoſophy, I have taken notice before, in my Eſſays, p. 141. to ſhew how Philoſophy was embarraſſed before the Diſcovery of a Medium more ſubtile and elaſtic than common Air.

It is clear beyond all doubt, that an attentive Reader of Sir Iſaac's Writings will find, that he fluctuated between two different and contrary Opinions; *viz.* that of an univerſal Vacuum, and that of an univerſal Plenum; his Principia inclining to the former, and ſeveral of his Queries to the latter.

In the ſecond Advertiſement to the third Edition of his Optics, he informs us, that to ſhew he did not take Gravity for an eſſential Property of Bodies, he had added a Queſtion concerning its Cauſe, which he ſuppoſes to be a ſubtile ætherial Medium,—readily pervading all Bodies—expanded through all the Heavens—cauſing the Gravity of thoſe great Bodies (the Comets, Planets, &c.) towards one another, and of their Parts towards their Bodies—and ſuch as may ſuffice to impel Bodies from the denſer Part of the Medium towards the rarer, with all that Power which we call Gravity. Optics, Query 18, 19, 20, 21. (*a*).

This the Rev. Mr. Jones has taken Notice of before, page 75, of his firſt Principles of Natural Philoſophy.

Any one might reaſonably ſuppoſe, that the Thought of a ſubtile Medium in the Pores of all Bodies, was almoſt always uppermoſt in Sir Iſaac's Mind, even while he was writing his Principia, ſince he concludes it with informing us, that "*now he might add ſomething concerning* "*a certain moſt ſubtile Spirit, which pervades* "*and lies hid in all groſs Bodies; by the Force* "*and Action of which Spirit, the Particles of* "*Bodies mutually attract one another at near* "*Diſtances*, &c. &c." (*b*).

But, pray inform me ingenuouſly, why you ſuppoſe ſuch a Vacuum and an univerſal Emptineſs throughout luxuriant Nature.

B. For many Reaſons, but particularly on Account of the regular and unretarded Motions of the Planets, both primary and ſecondary, in their ſeveral Orbits; ſince, notwithſtanding they have a compound Motion, their periodical Revolutions are always performed in exactly the ſame Space of Time, which muſt be a Proof that they move in a Space where there is no Medium of any Kind to diſturb, obſtruct, or retard their Motions.

(*a*) Eſſays, page 348.
(*b*) See his Princip. p. 393, or Eſſays, p. 36, 37.

Beſides, an univerſal Vacuum is abſolutely neceſſary to conſerve that conſtant and undecaying Motion which we obſerve among the Planetary Bodies; for be the elaſtic Medium ever ſo rare and fine, it muſt reſiſt in ſome Degree, which in length of time would become ſenſible; whereas the Motions of the Planets have continued the ſame, without the leaſt Alteration, ever ſince the firſt Commencement of Aſtronomy; conſequently, there muſt neceſſarily be a Vacuum, by which means, and the Force of a mutual Attraction, a gravitating Tendency of Bodies towards each other is accounted for in a rational and ſatisfactory Manner. What confirms the Truth of theſe Things, ſo as to put them paſt Diſpute, is, that they are demonſtrably proved by Sir Iſaac Newton's mathematical reaſoning in his Principia: Had he not been fully perſuaded of the Truth and Certainty of a celeſtial Vacuum, can it be reaſonable to ſuppoſe he would ever have undertaken and executed ſuch a Work as his *Principia*?

What indefatigable Pains, as well as fixed Reſolution, muſt it require to go through ſuch a Number of operoſe Calculations, in order to obtain the many uſeful Theorems contained therein? And, as was obſerved above, what muſt neceſſarily prove the Truth of the Opinion, is, that the general Phenomena, which are obſerved to prevail throughout Nature, are ſolved by theſe two Principles, *viz.*

thoſe of an univerſal Vacuum and a mutual Attraction of Bodies, even to a mathematical Demonſtration. —— Is not this Conſideration alone a ſufficient Proof of the Truth of the Aſſertion?

A. By no means: For as the Rev. Mr. Jones very juſtly obſerves on the ſame, “ 'Tis equal “ to the Mathematician, whether his firſt Prin- “ ciples are only imaginary and hypothetical, “ or whether they are real; the Operation will “ go on as ſmoothly, and the Concluſion come “ out as readily in the one Caſe as in the other; “ and if hypothetical and real Forces will “ equally afford Matter for an Aſtronomer to “ work upon, we may appeal to the Judgment “ of any ingenuous Man, ſufficiently verſed in “ mathematical Studies, whether the Pheno- “ mena above mentioned, *i. e.* whether a mu- “ tual gravitating Tendency of Bodies towards “ each other may not ariſe from a Preſſure “ *behind* as well as from an Attraction *before*, “ and whether Sir Iſaac's geometrical reaſoning “ will not be as concluſive in the one Caſe as “ in the other” (*a*). Page 92, of his Natural Philoſophy; or at p. 369, ſect. 156, of the Eſſays.

(*a*) Example, Let x be a Plenum, y the impelling Force, and z the gravitating Tendency. Then it will be, as x is to y, ſo will z be to $\frac{yz}{x}$: Conſequently it will be the ſame if x be put for a Vacuum, y for Attraction, and z the gravitating Tendency; for then x is to y, as z is to $\frac{yz}{x}$, as before.

If then it cannot be determined by mathematical Reaſoning, whether an univerſal Plenum exiſts in the celeſtial Regions, or whether an abſolute Vacuum; in order therefore to ſucceed in our Enquiries, we muſt have recourſe to Reaſon, Argument, Experiment, and Obſervation.

DIALOGUE VI.

Fire the Cauſe of Motion.---Laws obſerved by falling Bodies.---A remarkable Deception.---Of a Perforation through the Earth.---Of the Antipodes. ---Cauſe of Tides.

A. HERE it may not be unneceſſary to obſerve again, firſt, that Matter according to all Philoſophers is inactive and quite motionleſs, having no Affections, Qualities, or Properties peculiar to itſelf, but is entirely paſſive. Secondly, that ſince the World appears replete or full, as it were, of Motion, it muſt neceſſarily proceed from ſome active *Principle* or *Cauſe*. But, it ſeems, no active Principle was known beyond that of the common Air or

Atmoſphere, till another much more active was happily diſcovered by means of the electrical Apparatus, and in Form of Fire, that allowed active Principle and Cauſe of Motion; which Fire, on the ſtricteſt Examination, is found to be the ſelf ſame with that of Lightning (*a*); and by what appears from the niceſt Obſervations is every where diſperſed. Quære, which then ſeems moſt conſiſtent and rational, an univerſal Vacuum throughout the celeſtial Regions, and a mutual Attraction of Bodies, notwithſtanding their component Parts are inert; or whether an univerſal Plenum of the elaſtic *active* Principle, and an impelling Force; that is, whether a Vacuum and an interior Attraction between Bodies, or whether a Plenum and an exterior Preſſure from beyond them?

But excluſive of our Phyſico-mechanical Experiments, there are others of a more phyſical Nature, which point out a Motion of the æthereal Matter where it is ſeldom obſerved, altho' it be inceſſantly deſcending from the upper Regions, and paſſing through ſuch Iron Bars as are particularly deſcribed in the Eſſays, page 78, 406, and 421.

There are beſides thoſe, ſtill other natural Appearances whereby ſuch a Deſcent of an active Agent is diſcovered to be perpetually

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(*a*) Saving that the electrical Fire is much more pure than the Fire of Lightning.

paſſing down from the upper Regions to the Earth, which are rendered plain and obvious; particularly, when we enquire concerning that *Law* or Degree of Proportion of the Accelerations obſerved by falling Bodies; which *Law*, though it has not hitherto been ſo much conſidered as ſome others, is yet ſufficient to conduct us to many very uſeful and remarkable Truths, eſpecially, when we conſider the Effects of the above mentioned electrical Philoſophy.

B. What is the Law that is obſerved by falling Bodies, for I have almoſt forgotten it?

A. Firſt, their Acceleration is, as the Increaſe of the Times or Moments taken up from the Beginning of their Fall, in an arithmetical Progreſſion of the moſt ſimple Series, *viz.* 0, 1, 2, 3, 4, *&c.* whoſe Exceſs and common Difference is *one*, and for that Reaſon their Squares increaſe according to the odd, *i. e.* the uneven Numbers, 1, 3, 5, 7, *&c.* See the Eſſays, p. 406. Secondly, Bodies are obſerved to deſcend about the Space of 16 Feet in the firſt Second of Time from the Beginning of their Fall; therefore ſince ſixteen Feet and an Half are one Perch or Pole, and 320 Poles are one Mile, I ſhall call 16 *Feet a Pole*, and then 330 of thoſe Poles will alſo be one Mile. — The above mentioned Numbers and the Acceleration of falling Bodies will be more eaſily underſtood if committed to Writing, as in the following Tablet.

Sec.

Sec.	Squares.	Diff. of Sq.
0	0	
		1
1	1	
		3
2	4	
		5
3	9	
		7
4	16	
		9
5	25	
		11
6	36	
		13
7	49	
		15
8	64	
		17
9	81	
		19
10	100	

The firſt of the three Columns in the Margin exhibits the Seconds of Time.

The next Column are the Squares of thoſe Seconds.

The third Column contains the Differences of the Square Numbers.

The Sum of thoſe Differences or odd Numbers, 1, 3, 5, 7, *&c.* counting upwards, are always the Square of the Number of Seconds from the Beginning of the Fall.

EXAMPLE.

The Sum of the 2 firſt is 4 = the Square of 2.
The Sum of the 3 firſt is 9 = the Square of 3.
The Sum of the 4 firſt is 16 = the Square of 4.
The Sum of the 5 firſt is 25 = the Square of 5.
The ſame of the reſt, be there ever ſo many.

A Method ſo conciſe, and ſo very eaſy to diſcover the Time in which a falling Body will deſcribe any given Diſtance, excited my Curioſity to enquire, how long Time a Body would require to deſcend to the Centre of the Earth, (ſuppoſing it not to be reſiſted by the common Air) which Diſtance in round Numbers may be called 4000 Miles.

SOLUTION.

Since the Number of Poles or Perches contained in one Mile is 330 ſuch Poles, *viz.* Poles of 16 Feet, conſequently the number contained in 4000 Miles is 1,320000 Poles, the Square Root of which is 1148,9 = the number of Seconds which the deſcending Body would require to arrive at the Earth's Centre, ſuppoſing it paſſed through a free and open Space, *i. e.* = about 19 Minutes.

Here then are two things worthy of notice: Firſt, that although in the firſt Second of time its Deſcent would be no more than one Pole, yet ſo violent is the *Impetus* or *Cauſe* of the Accelerations, that in the laſt Second of time, its Deſcent at the ſame Rate, would be no leſs than 2295 of ſuch Poles, *i. e.* almoſt 7 Miles. Secondly, that the ſame Cauſe prevails at every particular Point of the Earth's ſurface, ſince Bodies deſcend with equal Celerity and Freedom from every individual part of it, conſequently the Cauſe of Gravity is general.

What a Violence this, which like an impetuous Torrent thus purſues the deſcending Body! How unlike is it to the greateſt Force that can be employed by human Art; ſince all other Forces are conſtantly diminiſhing as ſoon as begun, whereas the Accelerations of falling Bodies towards the Centre of the Earth, are always increaſing according to the Square of the Times from the Beginning of the Fall?—This natural Tendency of all Bodies towards the Centre of the Earth, at every Point of the Surface, furniſhes us, not only with the Cauſe of Gravity in general, but with the moſt remarkable Deception, with reſpect to the cauſe of the Gravity of our own Bodies; which, although we have all the Certainty that is poſſible, from Reaſon and Experience, as well as from falling Bodies, to convince us that the Cauſe of our gravitating Tendency towards the Centre is an exterior Preſſure; yet that Preſſure operates ſo naturally, ſo conſtantly, ſo regularly, and ſo imperceptibly, on every Part and Particle of our Bodies, that it appears to us to be a real internal Weight, juſt as if it were inherent, and ſeated within us, This deception is ſo remarkably prevalent, and the Senſe is ſo deluded, that we cannot poſſibly overcome the Fallacy.—Since then we are ſure to err and be miſguided by the Evidence of Senſe, the only ſure Method to conduct us to Truth is, to conſult the more unerring Teſtimony of our Reaſon, which aſſures us, even to a Demonſtration, that the Cauſe is external.

B. Of what real Advantage can the Inveſtigation of this Deception be to Philoſophers?

A. Unleſs we were previouſlyappriſed of ſuch a Deception, we ſhould be unable to explain the Doctrine of the Antipodes in a rational and ſatisfactory Manner.

B. How does the Diſcovery of that Deception enable Perſons to explain it?

A. By informing them that ſo long as they can ſtand or ſit upright, ſo long the Earth appears beneath them; and thus the Doctrine of the Antipodes is eaſily and naturally explain'd thereby.—Electrical Philoſophers therefore, and all others, may now very juſtly admire, that the Cauſe of Gravity was not known before.

From the Conſideration of falling Bodies, we are furniſhed with a Variety of uſeful Hints, and many Concluſions may be ſafely deduced from them.

Firſt, That although the Figure of the Earth is a Sphere or Ball, yet Bodies have the ſame Inclination or Propenſity to deſcend towards the Centre from every individual Part of it: This is an undoubted Proof that the *Cauſe* or *accelerating Force* is general.

Secondly, From theſe Conſiderations it as evidently follows, that it is an exterior *Force* or powerful *Preſſure,* inceſſantly impelling the deſcending Body towards the Centre ——— Hence the Earth, neceſſarily as it were, puts on that ſpherical Form.

Thirdly, The Doctrine of the Antipodes will alſo be illuſtrated by conſidering the Phenomena of falling Bodies. And as all Bodies have a natural Tendency towards the Centre of the Earth from every Part of the Surface, this conſideration will ſerve to leſſen what is held by many as one of the greateſt Paradoxes in Nature, namely, that every individual Point of a Sphere or Globe ſhould appear *uppermoſt* to the Inhabitants, where ever ſituated. — This Paradox is likewiſe ſolved by conſidering, that Bodies appear, when viewed, according as the Retina of the Eye is poſited; for if we view an Object with the Eye inverted, the Object, for that Reaſon, appears inverted; or if a Picture, *&c.* be ſet Bottom upwards, and viewed with the Eye inverted, the Picture then appears erect: conſequently, ſo long as we ſtand or ſit upright (the lower part of the Retina being then neareſt the Earth) ſo long the Earth will appear beneath us; ſince according to the Poſition of the Eye, ſo Objects neceſſarily appear.

Fourthly, From the Premiſes ariſeth, perhaps, as great a Paradox as the former, which is this. Were we to ſuppoſe a Perforation quite through the Globe of the Earth, and that ſpace were free and clear from a reſiſting Medium, in the Space of 19 Minutes a falling Body would arrive at the Centre of it, *viz.* 4000 Miles, nearly; at which Place it would meet with ſuch a Reſiſtance, as it had overcome but juſt before, which, though checked in its Career, muſt ſtill continue its rectilinear or right-lined Courſe, would, after it had paſſed the Centre, be, as it were, moving upwards, conſequently ſtill more and more retarded, till it arrived at the Antipodes, at which time the motion would be ſpent and quite at an end; after which, it would begin again to deſcend towards the Centre as at firſt, and the whole Proceſs be repeated: Thus it would continue to vibrate as a real Pendulum, whoſe Point of Suſpenſion was the Centre of the Earth, and the utmoſt Extent of its Oſcillation at Parts of the Surface diametrically oppoſite; that is, at thoſe Parts of the Earth where the Inhabitants were Antipodes to each other.

ILLUSTRATION.

It is well known to every Aſtronomer, that by Reaſon of the diurnal Rotation of the Earth, all Inhabitants at the Equator, who are Antipodes to each other, neceſſarily change Places every twelve Hours; that part of the Heavens which is the Zenith to the one, is, twelve hours after, the Zenith to the other.

Amongſt a variety of Indications that appear to point out an univerſal Plenum, the moſt promiſing one is, that of falling Bodies; for from thence we are furniſhed with ſufficient Data to proceed in many other Enquiries: By the Aſſiſtance of that Phenomenon, the Univerſality of the ſubtile Fluid is clearly and rationally pointed out, as likewiſe, that it is exceedingly elaſtic, and acts by preſſure on the Earth, and all planetary Bodies.

From the above Conſideration of ſuch an univerſal exterior Preſſure on every part of the Earth, electrical Philoſophers ſometimes take the liberty to query, whether the Cauſe of ſuch an univerſal Preſſure had any Share in the firſt Formation of the Earth; ſince, if it had not at firſt been ſo uniform, but of any multiform Figure, ſuch a violent univerſal Preſſure would neceſſarily cauſe it to put on the globular form in which it now appears: Or had all the Aſſemblage of the Parts and Particles of Matter of which the Earth is compoſed been ever ſo wide aſunder at the firſt, ſuch an univerſal Preſſure would naturally cloſe the Parts, and cauſe them to unite in a Sphere: However, ſuch a violent Preſſure on all parts of the Earth as is exhibited by that truly phyſical Experiment, is abundantly ſufficient to account for the *Conſervation* of the ſpherical Figure, if not the Cauſe of its putting on that Form at firſt.

The Doctrine of the Antipodes ſeemed a downright Contradiction to the Antients, and their Conceptions concerning ſuch Inhabitants were ſimilar to what might be reaſonably expected from Children.

Dr. Hakewill, in his Declaration of the Power and Providence of God in the Government of the World, Book 3d, chap. 8, p. 248, when ſpeaking of the Ignorance of the Antients relating to their Coſmography, ſays, " that " which to me ſeemeth more ſtrange is, that " thoſe two learned Clerks, Lactantius and

" Auguſtine, ſhould with that earneſtneſs deny " the *Being* of any Antipodes. Their Words " are worth the noting, thereby to ſee their " Confidence and Eagerneſs in the Maintenance of ſo evident a Miſtake. Lactantius " ſaith, What ſhall we think of thoſe who give " out there are Antipodes, that walk oppoſite " to us? Do they ſpeak any thing to the purpoſe; or is there any ſo blockiſh as to believe " there are Men whoſe Feet are higher than " their Heads; or that thoſe things there hang, " which, with us, lie upon the Ground; and " that Plants and Trees ſpring downwards; " that the Snow, Rain, and Hail fall upwards " upon the Earth; and need any Man to " marvel that hanging Gardens are accounted " among the ſeven Wonders of the World, " ſince Philoſophers have made both Fields " and Seas, Cities and Mountains, all hanging? " —Lactantius is here ſeconded by Auguſtine, " who ſaith, Their Fable of Antipodes, Men " dwelling on the oppoſite Part of the Earth, " where the Sun riſes when it ſets to us, having their Feet oppoſite to ours, is a Matter " altogether incredible, and by no means to " be believed."

" Zachary, Biſhop of Rome, and Boniface, " Biſhop of Mentz, led (as it were) by the " Authority of theſe Fathers, went farther " herein, condemning one Virgilius, Biſhop " of Saltzburg, as an Heretic, only for *holding* " that there were Antipodes. But Time and

"Travel," ſaith Dr. Hakewill, "have diſ-"covered the contrary ſo evidently, that we "may as well doubt of the being of a Sun "in the Firmament, as of the experimental "Clearneſs of this Truth."

B. What other general Concluſions do electrical Philoſophers draw from the Doctrine of falling Bodies?

A. That there is an univerſal and a violent Preſſure on the Surface of the Earth.—That the Preſſure muſt neceſſarily be univerſal, ſince Bodies fall with equal Freedom from every part of the ſurface, conſequently the ſame cauſe is every where preſent, and muſt neceſſarily produce the ſame effect. This, therefore, they conclude to be the phyſical Cauſe of the mutual gravitating Tendency of all Bodies towards each other, and towards the Centre of the Earth.

B. According to this Doctrine, all things that have hitherto been accounted for by Attraction, you attribute to Preſſure, or to Pulſion; but I am perſuaded you will find yourſelf miſtaken, particularly, in one Thing that I ſhall mention, which is, the Doctrine of the Tides, or the Flux and Reflux of the Waters of the Sea, particularly the former, which ſurely can never be accounted for by an univerſal Preſſure: It would ſeem very ſtrange indeed, if an univerſal Preſſure on the Surface of the Sea ſhould cauſe it to riſe in Tides.

A. I have ſo *thoroughly* conſidered and examined the Doctrine of falling Bodies, and an univerſal Preſſure on the Surface of the Earth, that I can venture to ſay, if there is any one thing that was uſually attributed to Attraction that cannot now be more rationally accounted for by means of an univerſal Preſſure, I ſhall think that one thing alone ſufficient to overthrow the Doctrine which I have adopted, of an univerſal Plenum throughout the mundane Syſtem, and will readily give it up.——As for the Doctrine of the Tides, I muſt own I never conſidered them ſo far as to attempt a Theory of them; however, were I to undertake it, I am perſuaded, I could account for them, by means of an univerſal Preſſure or Pulſion, in a much more rational and ſatisfactory Manner than ever it was poſſible to be done by Attraction.

B. Methinks I ſhould be glad of your further Explanation of your Sentiments upon this Subject.

A. In order thereto, I muſt premiſe two Things by way of Lemma. Firſt, the Univerſality of Æther, or ſubtile Medium. Secondly, that the Tides are influenced by the Preſence of the Moon.

Firſt, As to the Univerſality of Æther; this appears ſufficiently evident from what has been ſaid above on the Doctrine of falling Bodies.

Secondly, As to the general Appearance of the Tides, or Riſing of the Ocean being influenced by the Moon, that is too well known to be diſputed.

In the annexed Figure, let A, B, C, D, repreſent the utmoſt Bounds of the ſolar Syſtem; *a*, *b*, *c*, *d*, *e*, *f*, the Surface of the Earth; E, its Centre; and M, the Body of the Moon.

If then the Surface of the Globe was covered with Waters, it would be equally compreſſed on all Sides, and no Tide would happen were not ſome large Body near to it; but by means of the Interpoſition of the Body of the Moon, the ſame equal Preſſure muſt be interrupted at that part of the Earth at *a*, which is neareſt to M, and it would there be the leaſt preſſed; conſequently the yielding Waters would naturally flow to the part *a*, that is to *b*. *a*, *f*, higheſt at *a*.——It is manifeſt, that in this caſe there would be but one Tide at any particular Place every 24 Hours nearly, ſince the ſame Protuberance or Swell of the yielding Waters would accompany the Moon all round the Earth, and would then be exact and regular, and not interrupted, as it now is by the Land, by Capes, and Promontaries, *&c.*

But as there are two Tides inſtead of one, ſo no one doubts of their being cauſed by the Influence of the two Luminaries; but the greateſt Difficulty appears to be the following, *viz.* that notwithſtanding their Poſition and Diſtance from each other, which though continually varying, yet the Difference of the two Tides, relating to Time is nearly equal; this, however, is a Difficulty common to all Theories of the Tides: But as I obſerved, I had never

B. I ſhould be exceedingly well pleaſed with a Recapitulation of that Theory; for indeed, to ſay the Truth, I have forgotten it.

A. I ſhall think no Recapitulation troubleſome that can contribute towards your Improvement; and the rather, becauſe it will be neceſſary in the preſent Caſe to obtain a clear Idea of our Sun and Syſtem before the Nature and Office of the reſt of them can be pointed out; but of that Recapitulation farther on when I come to treat of the Cauſe of Gravity in general.

B. Of all your fundamental Principles, none is ſo ſtrenuouſly oppoſed as the very firſt, that of an univerſal Plenum. If ſuch a Principle be but mentioned, it is ſure to be rejected as fabulous.

The Maintainers of the eſtabliſhed Philoſophy affirm, that were there not an univerſal Vacuum, there could be no ſuch thing as Motion; for ſuppoſing an univerſal Plenum, inſtead of an undecaying Motion of the Planetary Bodies, it muſt be abſolutely impoſſible for them to move at all, unleſs two Bodies could exiſt in one and the ſame identical Space, which is allowed to be the greateſt Abſurdity.

A. In Anſwer to this grand Objection, I ſhall cite a Paſſage from that celebrated Writer, the Rev. Mr. Jones, frequently mentioned in my Eſſays, who having in the 4th chap. of the 1ſt book, p. 29, of his Eſſay on the firſt Principles of Natural Philoſophy, been treating of the *Vis inertiæ*, proceeds in the former Part of his 5th chap. p. 39, in the following Manner.

"Thus much, I think, may ſuffice to ſhew, 'that the celebrated Demonſtration of a *Vacuum* has *ſet out* wrong. It will be as eaſy 'to prove, even waving all that has been ſaid 'on the *Vis inertiæ*, that it has *concluded* 'wrong; if the *relation between a moving body* '*and a reſiſting medium* be rightly underſtood."

"When a Pendulum is made to ſwing in '*Air*, *Water*, or *Mercury*, the Reſiſtance it 'meets with is greater, as the Medium is 'denſer: And as a Plenum of Æther, ſuch as 'the mechanical Philoſophy requires, would 'be more denſe than any other Fluid, its 'Reſiſtance, they ſay, muſt be greater: No 'Motion could poſſibly continue in it. But 'then as Motion is obſerved to continue in the 'Heavens, without any *ſenſible Diminution*, 'there can be no Reſiſtance in the heavenly 'Spaces, and conſequently no Matter of ſuffi'cient Denſity to occaſion it."

"This was Sir Iſaac Newton's Way of 'computing Reſiſtances, and the Uſe he made 'of them when computed. That we may ſee 'whether this Doctrine agrees with Experi'ence, let us ſuppoſe a Ship, with its Sails 'ſpread, to be in Motion before the Wind; 'every body muſt allow me, that if the Wind 'were to keep its Direction, and the ſhip to 'have an open Sea, it would go quite round 'the Globe; and for the ſame Reaſon that it

‘ makes one Revolution it would make another, and ſo on *ad infinitum.* Are we to ſay, that the *Air,* in which it moves, is an *unreſiſting Medium?* We ought to ſay this, if ‘ the Demonſtration above mentioned really ‘ is what it pretends to be. But the Truth is, ‘ a Medium may, *in its Nature,* be a reſiſting ‘ one, and yet, *in fact,* give no ſuch Reſiſtance, ‘ as ſhall be any Impediment to a Body moving ‘ in it. For let any Perſon tell me, how much ‘ Reſiſtance the ſhip receives from the Air in ‘ this Caſe? The Anſwer muſt be — leſs than ‘ none: The Reſiſtance here is a negative ‘ Quantity; and the ſhip is ſo far from *loſing* ‘ its Motion, that it is continually *receiving* it, ‘ as it paſſes through the Air; yet it would be ‘ falſe to affirm of Air in general, that it is not ‘ a reſiſting Medium. As to the *Water* the ‘ ſhip ſails upon, this being not the *Cauſe* of ‘ its Motion, will ſerve to retard it: But as ‘ the continued Impulſe of the Air behind, is ‘ ſuperior to the Sum of all the following Reſiſtances, 1ſt, of the *Air before,* 2dly, of the ‘ *Water* the ſhip ſails upon, and 3dly, of the ‘ *Cauſe of Gravity* which is continually acting ‘ upon it; the Motion will continue notwithſtanding theſe Impediments.”

“ Were it to be laid down as a general Rule ‘ from this particular Inſtance, that *Water* reſiſts Motion, but *Air* does not; neither will ‘ this coincide with Experience. A Cork, or ‘ any other light Body, thrown upon the

'Stream of a Sluice or Floodgate, will be carried off with it; and as it is common for a 'conſiderable Part of the Water to return 'again upon the ſtream in a Curve, if it be 'obſtructed by the Banks, or have but a narrow Outlet, the Cork may come about with 'it, and compleat its Revolutions, ſo long as 'the Cauſe continues to act upon it. The Water gives no more Reſiſtance in this Caſe, than 'the Air did in the other: And thus it will 'happen univerſally, that every Fluid, where it 'is the *Cauſe of Motion*, will not be found in 'that Caſe to give any *Reſiſtance*, be its Quantity of Matter great or ſmall."

"We are now prepared to return to the 'Pendulum. If it vibrates in *Air*, the Air will 'retard its Motion; and there is a good Reaſon why it ſhould do ſo, for Air is not the '*Cauſe* of its Motion. If in *Water*, neither is 'that the Cauſe of its Motion; and it will give 'a greater Reſiſtance to it in proportion to its 'Quantity of Matter; that is, in proportion 'to the Action of Gravity upon it. If in *Quickſilver*, it will meet with a ſtill greater Reſiſtance, for the ſame Reaſons. But if there be 'any elementary Æther, acting as the natural '*Cauſe of Gravity* in Bodies; it is juſt as abſurd, 'to ſearch for the Reſiſtance of *ſuch a Fluid* 'from the Motion of a *falling Body*; as for that 'of the *Air*, from the Motion of a ſhip that 'ſails by it; or for that of *Water*, from the 'Motion of Bodies carried down by a Current

' of it. If one Philoſopher may conclude, that
' Gravity cannot be owing to any material
' Fluid, becauſe he has found that this Fluid
' does not *reſiſt* a gravitating Body; may not
' another demonſtrate with equal Truth, that
' a ſhip cannot ſail by the Action of the Air
' upon it, becauſe he finds, from the niceſt
' Obſervations, that the Air does not *deprive* it
' of its Motion."

" Whether the learned will conſider of theſe
' Things, I cannot pretend to judge; in Time
' perhaps they may: But for a while, I preſume,
' he that ventures to interpoſe, muſt be
' content to let the Reproach fall upon himſelf.
' There was a Time when Men had given up
' their Underſtandings to the Logic of the
' Schools (*a*) and the Quirks of Ariſtotle; and

(*a*) " I will give a Specimen of their *Manner* pertinent to the
' Subject we are upon. It is a *Logical Demonſtration* of a *Vacuum*,
' extracted from Lib. 4, c. 6. of Ariſtotle's Phyſics. *If there be*
' *no* Vacuum, *there can be no* Loco-Motion *For a Space already full*
' *cannot receive any thing into it; if it did, there would be two Bodies*
' *in the ſame Place; which is an Abſurdity.* Some of his Commen-
' tators put it thus —— Probatur Aſſumptio; quia Corpus quod
' Locum mutat, vel inani Spatio excipitur, vel pleno: Si inani,
' habetur Propoſitum: Si pleno, ſequitur duo Corpora ſeſe per-
' meare. —— *The Aſſumption is thus proved; becauſe a Body that*
' *changes its Place is received either into a Space* full *of Matter, or*
' *into one that is* empty: *If into an empty Space, the Point is proved;*
' *if into a full Space, then it follows that two Bodies muſt penetrate*
' *one another's Dimenſions.* And Arittotle tells us of one Meliſſus,
' an antient Sophiſt, who being reduced to the laſt Extremity
' by the Force of this miſerable Argument, and determined not to
' admit a *Vacuum*, denied the Reality of Motion, and held the
' Univerſe to be immoveable. Had this Philoſopher truſted to

‘ woe to the Man who dared to publiſh a
‘ Suſpicion againſt them. That Faſhion is
‘ now exploded, and we are all enſlaved
‘ to the Pretences of a *mathematic* Certainty.
‘ But if the Doctrine of a Vacuum is really
‘ weak and without Foundation, this Faſhion
‘ will have its Period like the former, and
‘ we ſhall be reſtored again to the Enjoyment
‘ of our philoſophical Rights and Liberties.”

Thus you may ſee how even many ingenious and learned Men delude themſelves, by embracing the miſtaken and fallacious Arguments of others without examining them.

‘ Experiments inſtead of Logic, he might have ſilenced his Adver-
‘ ſaries with very little Trouble. For if a Bullet be put into a
‘ Bottle quite full of Water, and cloſe ſtopt down, we have a
‘ Space filled with an *incompreſſible Fluid*; which conſtitutes as
‘ good a Plenum as need be deſired; yet upon inverting the Bottle,
‘ we find the Bullet can move from the Top to the Bottom, or from
‘ one Side to the other, as freely as if the Bottle were empty —
‘ Does it move into an empty Space, or into a full one? Why
‘ truly into neither; for the Bullet and the Fluid *change Places*
‘ with one another, ſo that the Motion is not hindered, though
‘ the Space is always full of Matter.”

DIALOGUE

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DIALOGUE VIII.

Of the Pneuma.-Of two electrical Æthers. --The Manner in which the gilded Phial or the gilded Saſh-pane is charged, and of Poſitive and Negative Electricity.--- The Leyden Experiment inveſtigated.

B. WHAT am I next to conſider?

A. One Thing more ſeems neceſſary to be known by every electrical Philoſopher, in order to render Experiments more clear and intelligible; which is, that in a Variety of of Experiments, there are Effects that ſeem as widely different from what are obſerved in common, as if they proceeded from two different Agents: Probably, the Effects are different Phenomena produced by the ſame Agent, acting in different Forms; ſince they ſeem not independent of each other, but co-exiſtent: The one Part appears from the Effects to be much more ſubtile and active than the other: The one ſeems incapable of penetrating a Glaſs Body while replete with Air: The other pervades it at the ſame Time with the greateſt Freedom, acting on ſmall Bodies within ſide of the Glaſs as if nothing were between them: The more ſubtile active Part, called *Pneuma*, or Spirit of Æther, is an Apellation borrowed from the renowned Lord Bacon, as you will find in the 6th chap. of my Eſſays, where that great Author treats at large of Spirits and Pneumaticals. In that, and the chapter following, are many Experiments which illuſtrate and confirm the Exiſtence and Reality of ſuch an active Pneuma or Spirit; the Knowledge of which is another valuable guiding Clue, not only to the Solution of many electrical Experiments, but to other abſtruſe Phenomena of Nature, which are otherwiſe inexplicable; and therefore well worthy of our Inveſtigation. — By having no Regard to ſuch a Pneuma, or Spirit of Æther, many Electricians, from Obſervations and Appearances of the like nature, have been of Opinion that there were really two different and diſtinct electrical Fluids, as appears from Dr. Prieſtly's Hiſtory.—" It had hitherto," he ſays, " been univerſally ſuppoſed, that all the Phe-" nomena of Electricity were produced by the " Action of one electrical Fluid." Mr. Du Fay however imagined he had diſcovered another electrical Fluid, diſtinct from that of Glaſs, and peculiar to that of Reſin, &c. and thought that it was quite independent of the other, and that their Operations were never combined. Mr. Symmer exhibits a Variety of curious Experiments relating to the ſame Subject, and infers from them the probable Exiſtence of two electrical Fluids; not independent, but always co-exiſtent, and counteracting one another.

The Abbé *Nollet* ſeems not to be of the opinion that two ſuch Æthers exiſt, but maintains two contrary Currents of the ſame Fluid continued; and (to uſe his own terms) concludes, *that a ſimultaneous Effluence and Affluence of a fluid Matter, extremely ſubtile, conſtitutes Electricity.*

Is not the Opinion of two different ſubtile Mediums or Æthers like ſtraying too wide from ſimple Nature, and conſequently too unphiloſophical to be admitted? Does not ſuch an univerſal ſubtile Æther and a Pneuma, as we have diſcovered, ſeem abundantly ſufficient to ſolve the Phenomena; particularly, when we conſider it as endued with various Affections, Qualities, and Properties, acting in different Capacities, Conditions, and Forms? This Doctrine is likewiſe agreeable to Sir *Iſaac Newton*'s firſt Rule of reaſoning in Philoſophy, viz. *We muſt admit no more Cauſes of Natural Things than what are true and ſufficient to explain their Appearances; Nature being pleaſed with Simplicity, and affects not the Pomp of ſuperfluous Cauſes.*

I ſay, do not two ſuch univerſal ſubtile Mediums look too much unlike ſimple Nature to be admitted? Is it not more rational to ſuppoſe, that what are thought to be the Effects of another electrical Fluid, are produced by ſo many Appendants, as it were, and, in fact, nothing more than, as before obſerved, the ſame Agent acting in different Capacities, different Forms and Modes, and in different Circumſtances?—What we term Poſitive and Negative Electricity is by no means a ſufficient Proof of two electrical Fluids, they ſeem only different Modes of the ſame univerſal Agent.

B. I cannot ſay I am very well acquainted with the Term Negative Electricity: I ſhould therefore be glad to be better informed concerning it.

A. To render it as plain and obvious as poſſible, I ſhall be here obliged, for more Reaſons than one, to tranſcribe the greateſt part of the 11th chap. of my Eſſays, part the 1ſt; where you will find the manner that the Saſh-pane, and the Glaſs Receiver or Leyden Phial are charged; which will help to convey an Idea of what is meant by Negative Electricity, and is as follows.

" *Firſt*, Let A and B repreſent two Perſons, and let A be electriſed on the Reſin-cake, while B is only on the Floor."

" *Secondly*, Let a Saſh-pane properly gilded on both ſides be held between them with its Plane in a perpendicular poſition, and the Edge of it towards each Perſon, that ſo the two Sides of the Pane may the more eaſily be viewed at once."

" *Thirdly*, If each Perſon approach a different ſurface of the Pane with a Finger at nearly equal Diſtances, when they are about Half an Inch from the ſurface, a Spark will dart from the Finger of each to the Glaſs.—This is performed ſo inſtantaneouſly, as to appear but one ſingle

Spark, *i. e.* from the electriſed Finger of A, thro' the thin Glaſs, to the unelectriſed Finger of B; but the effect ſhews the contrary: For was that the caſe, the Pane would not be affected thereby, whereas a few of theſe Operations charge it. It will as plainly appear that the Phial is charged the ſame way. For if a Phial be ſet on an electric Cake, and A and B approach it with their Fingers, the one near the Cork-wire, and the other near the Coating, when they are at the proper Diſtance, Sparks will dart from each Finger at the ſame Inſtant, and the Phial will be charged as the Pane was before."

" But what is moſt remarkable is, that tho' it be found neceſſary to electriſe both ſides of the Pane or Phial before it will produce the deſired Effect; yet if both ſides were electriſed from the Machine, or from *two* different Machines, it is of no more effect than if only one ſide of it was electriſed.

" The moſt commodious Way of managing the Phial is to take it in the Hand, for by that means the Experiments will be more eaſily made, and the Effects more viſible, than when it hangs on the Prime Conductor; and conſequently may be explained in a more eaſy and familiar manner: For A being electriſed, his Hand which holds the Phial is, with regard to the Phial, the Prime Conductor, not only when he holds it by the Cork-wire, and by that means electriſes the Inſide; but if, inſtead of that he holds it by the Coating, that only will be electriſed.—Firſt then, if he take it by the Cork-wire, it will be in the ſame ſituation as the gilded Saſh-pane was, when A laid a Finger on one ſide only; that is, ſince he will not be convulſed by bringing his other Hand to the Coating; but if he remove that Hand from the Coating, and B on the Floor lay on his Hand or Finger on the Coating, it will ſoon be ſufficiently charged; for if after that A lay his Finger to it again, he will then be ſhocked as uſual.—The ſame Effect will follow, if inſtead of holding the Phial by the Wire, he take it by the Coating, and hold it ever ſo long in his Hand, the Coating only will be electriſed; for if after that he bring his Finger to the Wire, he feels nothing; but if B, ſtanding on the Floor, lay on his Finger, the Phial is then very ſoon compleatly charged; for if A put his Finger to it again, he is then convulſed. So that in either caſe, the Phial, according to Dr. *Franklin*, was electriſed *plus* and *minus*, *i. e.* firſt, when A held it by the Cork-wire, the Inſide was electriſed *plus*, and the Coating *minus*; and ſecondly, when he graſped it by the Coating, that was electriſed *plus*, and the Inſide *minus*, or in a State of Want: In either caſe the Phial could never be charged, till the other ſurface of it was furniſhed from the Hand of B on the Floor."

"In like manner if B on the Floor takes the Phial into his Hand, either by the Cork-wire or by the Coating, the ſame effects will follow:

If by the Coating, the Inſide will be electriſed if A lay a Finger on the Wire; for after this B will receive the Shock, if he bring his other Hand to the Wire: And the ſame Effect will be produced, if inſtead of his holding it by the Coating, he ſhould hold it by the Wire; for then A electriſes the Coating, by laying his Finger on that."

"Hence the ſimilarity of the Phial and gilded Saſh-pane; from either of which a Phenomenon is exhibited, which perhaps was hardly thought of before, namely, that when the glaſs Receiver is properly charged, one Side of it is actually electriſed immediately from the Earth, thro' the Chain or other non-electrical Body communicating with it.——Is not this a plain Intimation, that the electrical Fluid which is produced from the Earth is in a Negative ſtate, ſince that is the ſtate of the Coating of a charged Phial, *viz.* that Side of it which communicates with the Earth at the Time of charging it, whether it be the Inſide or the Outſide?"

Hence it may be ſafely concluded, that the Electricity, as it is called, *i. e.* the Æther which is obtained immediately from the Earth or Floor, is in a negative ſtate, which may very probably be the natural Cauſe of the Thunder-clouds being for the moſt part in ſuch a ſtate; as Dr. *Franklin* obſerved them to be.

The 12th and 13th Letters of his 2d Edit, contain a particular Account of Electricity, by Experiments made with his Iron-rod from the

Top of his Houſe; in moſt of which it was in a negative ſtate: Sometimes indeed, though but ſeldom, it was, for a ſmall Time, in a poſitive ſtate.

The Dr. advances what ſeems very rational at p. 119, *viz.* why the Fire of Lightning may be *expected* to be in a negative ſtate, *viz.* "When 'a Portion of Water," he ſays, "is in its 'common denſe ſtate, it will hold no more 'electrical Fire than it has.—When the ſame 'Portion of Water is rarefied into Vapour and 'forms a Cloud, it is then capable of receiv'ing and abſorbing a much greater Quantity; 'there is room for each Particle to have an 'electric Atmoſphere."

"Thus Water in its rarefied ſtate, or in the 'Form of a Cloud, will be in a negative ſtate of 'Electricity; it will have leſs than its natural 'Quantity; that is, leſs than it is capable of 'attracting and abſorbing in that ſtate."

The Manner how the Shock *in the* Leyden Experiment *is generated and propagated.*

Having carefully advanced thus far, on what it is preſumed will be allowed to be ſufficient Evidence; ſince there is nothing either ſtrained, fictitious, or arbitrary; no other Properties or Qualities having been aſcribed to this Æther than what are plainly diſcovered and verified in it, moſt of which were foretold by Sir *Iſaac Newton* many Years ago: Particularly, firſt, *That it is much like Air in all reſpects, but far more ſubtile.* See his Letter to Mr. *Boyle.* Secondly, *That it lies hid in the Pores of all groſs Bodies,* in the manner foretold in the laſt Paragraph of his Principia. And almoſt all Experiments are on his ſide, and loudly proclaim the ſame Properties; which are ſo obvious, that whoever is converſant with them, or will but take the leaſt trouble to inform himſelf, can neither miſs finding ſuch a Fluid to exiſt in the Pores of Bodies, nor after he has *pumped* it out (*a*) with the electrical Machine, can eaſily be ignorant of its inherent Rarity and Elaſticity.—I ſhall endeavour next to inveſtigate the means by which that inconceivable Violence is generated in the Leyden Experiment, by the ſame cautious Method.

In order to perform ſo difficult a taſk, which has hitherto baffled every Attempt, I ſhall here collect ſome Poſitions, which have been already proved, and try how far they are capable of aſſiſting me in the arduous Undertaking.

Firſt, That the conſtituent parts of Æther, contained in Bodies, conſiſt of all Degrees of Rarity, or rather, all Degrees of Purity; agreeable to the Nature of it, as deſcribed by Sir *Iſaac* in his fore-mentioned Letter to Mr. *Boyle.*

(*a*) We know, ſays Dr. Franklin, that the electrical Fluid is in common Matter, becauſe we can *pump* it *out* by the Globe or Tube. See the 2d Edition of his Letters, page 53.

Secondly, That the moſt pure, rare, and ſubtile Part of it, is alſo the moſt elaſtic and active: And that this Rule holds equally true in all the intermediate Gradations, from the moſt pure ætherial Part, down to the groſſeſt common Air.

Thirdly, That the ſubtile Æther contained in the Pores of the moſt perfect non-electrical Bodies, is looſe, free, and fluid, as in Metals, Water, Animals, and green Vegetables, eſpecially in the two former; and, in various Caſes, it is found, from the ſtricteſt Obſervations, to move freely out, provided it be for an equal Quantity of the ſame Fluid to ſucceed it.

Fourthly, That in all Degrees of Attrition, a proportionate Degree of Expanſion is exerted, at leaſt to a certain Height: And ſince the homogeneous Particles mutually repel each other, and, conſequently, the Maſſes compoſed of them; the expanſive Force therefore of the pure Air, or Æther, is ſo much ſuperior to the expanſive Force of the common Air, that the Limits occupied by a Maſs or Aſſemblage of the former, ſuch as the Accumulations on Bodies when electriſed, muſt conſequently, by being ſo much more elaſtic than the latter, buoy it up; that is, repel and bear it away from the Body on which the Æther is accumulated: By this means the Equilibrium is deſtroyed, and in the ſame Proportion, as the Rarity of the Æther within thoſe Limits exceeds that of the common Air which ſurrounds it; and, conſequently, that thoſe Limits may be conſidered as ſimilar to a temporary Vacuum with reſpect to the Air, eſpecially ſince the Effects of almoſt all electrical Experiments verify the Facts, and therefore juſtify the Concluſion.

Fifthly, That the Æther is firmly fixed in all the Parts of Amber, Glaſs, Reſin, Wax, and all other Bodies, termed original Electrics. See p. 104, ſect. 204, of the 1ſt Part of the Eſſays.

Sixthly, That when thoſe ſubtile Particles are irritated by Attrition or Friction of any kind (which is the caſe when the Glaſs is rubbed, ſince by being fixed in all Parts of the Glaſs it is incapable of eſcaping from the Inſtrument of Friction,) we can always obſerve, from the Effects of every ſuch Experiment, that the Equilibrium of the adjacent Air is deſtroyed, and that the fore-mentioned *Pneuma* or *Spirit* is inceſſantly paſſing into ſuch rarefied Limits from all the ſurrounding Parts, and by that means impels light Bodies into them. (*a*)

A ſmall Attrition of the Glaſs, or a Piece of good Amber, is ſufficient to produce thoſe Effects; as appears from Mr. *Boyle*'s Experiment with a Piece of Amber when only laid in the Sun, or even a Glaſs warmed by the Fire,

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(*a*) From the Effects of the Experiments, thoſe Limits appear to be the moſt rare and elaſtic of all, at the very Surface of the electriſed Body, whether it be the rubbed Glaſs, or whether it be any other Thing electriſed: and that from the Surface of the electriſed Body to the Extremity of thoſe Limits, ſuch Rarity and Elaſticity gradually decreaſe; the included Æther becoming more and more groſs, from the Body on which it is accumulated.

which by that means became electrical. See Vol. I, p. 400, of Mr. *Boyle's* Works, abridged by Mr. *Shaw*; or Eſſays, p. 425, ſect. 273.

If then ſo inconſiderable an Attrition as the Sun's Beams ſtriking on the Surface of thoſe Bodies where the Æther is fixed, be yet ſufficient to cauſe ſuch an Emanation, or, (as he terms it) Effluvia emitted by the Glaſs, we have the leſs room to admire, if the ſame Emanation be extended to a much greater Diſtance from the Glaſs, when the Æther at the Surface of it is irritated by violent Friction. — But the Effects of thoſe *Effluvia* or Emanations extended from the fixed Æther in the Glaſs, are not only viſible on the rubbed Side of the Glaſs, but extend themſelves quite through it, if it be not too thick: For if a Pane of Glaſs be held over light Bodies, and rubbed, the Equilibrium is deſtroyed on the under Surface, as is found by the Effect; thoſe light Bodies being impelled towards it in the ſame manner as to the rubbed Side. When the Friction at the Surface of the Glaſs ceaſes, the ſame elaſtic and rare Emanation ſoon ſhrinks back again to the Origin from whence it came.

Seventhly, Attrition on the Surface of Glaſs, was the only way that was known of electrifying it, till another was accidentally diſcovered to Profeſſor *Muſchenbroek*, *viz.* that of confining a thin Glaſs between two denſe Non-electrics, and then electriſing one of them, by ſuffering it to communicate with the excited Apparatus, where the Effects are very remarkable: For no ſooner is the Prime-conductor, *&c*, electriſed, but that Surface of the Glaſs which communicates with it is electriſed alſo; at which Time the ſubtileſt and moſt elaſtic Part inſtantly pervades the thin Glaſs, and there impels, buoys up, or bears off the common Air, and rare Limits are formed on that Surface likewiſe, as we find by the Effects; and light Bodies are as forcibly impelled to that Surface as to the other.

And to that moſt rarefied Surface the Spirit or Pneuma ſets in from the Earth, thro' denſe Non-electrics, ſo freely, that the Glaſs ſoon becomes ſufficiently charged; that is, it is then what Dr. *Franklin* calls "electriſed in the "common way."

"When a Bottle," he ſays, "is charged in 'the common way, its inſide and outſide Sur'faces ſtand ready, the one to give Fire by the 'Hook, the other to receive it by the Coating; 'the one is full and ready to throw out, the 'other empty and extremely hungry: Yet as 'the firſt will not give out, unleſs the other 'can at the ſame inſtant receive in; ſo neither 'will the latter receive in, unleſs the firſt can 'at the ſame inſtant give out. When both can 'be done at once, it is effected with incon'ceivable Quickneſs and Violence."

Or in other Words, the inſide Furniture of the Phial having a Property of retaining the Æther obtained from the Machine, that Surface is, according to Dr. *Franklin*, electriſed *poſitively* on account of its being there more ſtrongly retained than by any other means; and the coating is for the ſame reaſon electriſed *negatively* in as high a Degree, which ſurface he terms extremely hungry: When theſe two Surfaces are in this State, and a non-electrical Circuit compleated from the one to the other, the Equilibrium is inſtantly reſtored at both, and with inconceivable Violence.

The *Plenum* at the one Surface electriſed by the Machine eſcapes into the *Vacuum* at the other, *i.e.* the Redundancy on one is diſcharged on the other, which the Doctor terms ſo extremely hungry, and thus the Equilibrium is inſtantly reſtored at both, thro' the non-electric Circuit, with the utmoſt Violence; whether it be long or ſhort, regular or irregular, or with ever ſo many Turnings and Windings.

The ſudden and violent Shock is propagated throughout the non-electric Circuit by means of the Continuity of the Particles of the Æther contained in it, from one End to the other; and notwithſtanding the Irregularity of the Circuit, yet the contained Æther is moved in a ſimilar Manner, and with the ſame Freedom, as every Part of the Circumference of a ſolid Circle or Wheel is conceived to be moved, were ſuch Wheel to be turned on its Axis: For otherwiſe it would be difficult to imagine how a Motion could be communicated to every Part of the largeſt Circuit poſſible, as inſtantaneouſly as to the ſmalleſt.

DIALOGUE

DIALOGUE IX.

A Definition of a complete Sceptic.---*Of making Obſervations ones ſelf and of taking them on Truſt.*-----*Sir* Iſaac's ſecond Rule *condemned.*----- Microcoſm *and* Macrocoſm.---- Mambrino's *Helmet.*

A. A Very reſpectable young Gentleman of my Acquaintance in a neighbouring County, having lately returned from his Travels, wrote to me, and, among other Things, informed me, that he had been taught Philoſophy by many different Maſters, each of whom had adopted a favourite Theory of his own; and added, I am become quite a Sceptic in Matters of Opinion, and even frequently in Deductions from Facts.

This, it muſt be allowed, is a moſt ſtrange Confeſſion; and ſhews him to be gotten into the very Track which muſt neceſſarily conduct him to that Bane of all Science, *Scepticiſm*; *viz.* that of being taught Philoſophy by a Multiplicity of Maſters, each of whom had adopted a favourite Theory of his own.

B. Do you think Scepticiſm to be a natural Conſequence of being taught Philoſophy by different Maſters?

A. It muſt ſeem naturally to tend to it, when each of thoſe Maſters had adopted a particular favourite Theory of his own.—— When my Friend was initiated into the Principles of the Theory of his firſt Maſter, no doubt but he might be well pleaſed with them, and by that time he had digeſted thoſe Principles, perhaps he might imagine they were not to be refuted; but having enliſted under another Maſter, who had adopted a different Theory, he was ſoon unhinged, as it were, with regard to the Principles of his firſt; and having attentively conſidered thoſe Principles of his ſecond Maſter, he might by that Time very poſſibly imagine himſelf capable of inſtructing his former Maſter, thinking he was then arrived at the higheſt Pitch of Knowledge; but he ſoon became convinced of his Miſtake by his third Maſter, who had adopted a different Theory from the reſt. Thus by going from Maſter to Maſter, and ſtill finding that each one had adopted different Principles, he at length became quite a Sceptic, as he himſelf owns, inſomuch as frequently to doubt even the Evidence of his Senſes, or what he ſtiles Deductions from Facts.

I muſt own, I could not but reflect with a kind of Complacency on the remarkable Difference between that young Gentleman's Manner of being initiated into the *Search of Nature* and that of my own, and the different Effects produced thereby —He, who was taught Philoſophy by different Maſters, became quite a Sceptic; whereas, I had no Guide beſides the Dictates of Reaſon to conduct me, and the Manner whereby the Effects of electrical Experiments are reconciled with one another.

He alſo added in the ſame Letter, that he had peruſed my Philoſophical Eſſays with great Pleaſure; though (he ſaid) he continued to think that my extenſive Application of the electrical Power was by no means founded on ſufficient Experiments; yet, that it was with great Pleaſure he ſaw new Facts daily ariſing in Confirmation of it. And ſays, though I cannot conſider you as a Philoſopher who has proved the Point, I muſt look upon you as a Prophet who has foretold it.

When I had Thoughts of writing a Supplement to thoſe Eſſays, I wrote to him again, and to many others of my Acquaintance, to deſire them to favour me with what Objections they thought any particular Parts of them were liable to: My Reaſons for deſiring it I have given farther on.

From my Friend's preſent Anſwer, I have great Reaſon to conclude, that his Paſſion for Scepticiſm has not abated ſince his firſt Epiſtle. He obliged me indeed ſo far as to ſend me many Objections to what I had advanced; but in ſo curſory, captious, ſneering, and ludicrous a manner, that if he had not profeſſed himſelf to be, *upon Principle*, a philoſophical Infidel, I ſhould have thought myſelf ill-uſed by him.

The firſt Thing he objected to, was what I had tranſcribed out of Biſhop *Berkeley's* Siris, and from Profeſſor *Boerhaave*, concerning the Vivifying Spirit in Air: To which, all the Reply he makes is, " Vivifying Spirit not " demonſtrated."

The Gentleman objecting againſt the Vivifying Spirit in Air, becauſe he thought it not ſufficiently demonſtrated, brought to my Mind an Experiment of Mr. *Haukſbee*, made on Fiſhes; which, as it ſeems a full Proof of what he thought was not ſufficiently demonſtrated, I ſhall take the liberty to inſert it in the Author's own Words, ſee Mr. *Haukſbee*'s Phyſico-mechanical Experiments, exp. 16th, p. 304.

" The Fiſhes made uſe of in the following ' Experiments were Gudgeons, which are a ' ſort of Fiſh very briſk and lively in the Water, and will live a pretty conſiderable Time ' out of it. Three of them I put into a Glaſs ' Veſſel to about three Pints of common Water ' (which Fiſhes were to be a Standard to compare the others by.) Into another Glaſs, to ' a like Quantity of Water, I put three more ' of them, which quantity of Water juſt filled ' this Glaſs to the very brim; upon which I ' ſcrewed down a braſs Plate with a Leather ' between, to prevent a Communication with ' the Water in the Glaſs and the external Air:

‘ And that it might the better reſemble a ‘ Pond of Water frozen over, (on which account this Experiment was made) I ſuffered ‘ as little Air as poſſible to remain on the Surface of the included Water.”

“ The third Glaſs had a like Quantity of ‘ Water put into it as the former; which Water, firſt by boiling, then by continuing it a ‘ whole Night in *Vacuo* on the Air-pump, was ‘ purged of its Air to the greateſt Nicety (*a*): ‘ Into this Water alſo, I put a like number of ‘ Gudgeons as into the other. Thus (the ‘ Fiſhes being all put into their reſpective Receivers) I applied myſelf to wait the Event, ‘ which was as follows: It was about half an ‘ Hour after Ten in the Morning when I began the Experiments; and in about half an ‘ Hour from that Time, I obſerved the Fiſhes ‘ in the exhauſted Water, or Water purged of ‘ its Air, began to diſcover ſome Uneaſineſs, ‘ by a more than ordinary Motion in their

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(*a*) “ From Experiments made with the electrical Apparatus, ‘ it never appeared that the Fluid in the Pores of Bodies could ‘ ever be taken away or removed by any means, otherwiſe than ‘ for an equal Quantity of the ſame Matter to ſupply its Place, ‘ conſequently there is no ſuch thing as purging the Water ‘ of it in the Manner Mr. Hauksbee ſuppoſed. It was morally ‘ impoſſible for him to have the ſame Reaſons to believe that Fluid ‘ to contain an elaſtic Fire, as we find it does; and that not the ‘ leaſt Portion of it can quit its Place, but for an equal Quantity ‘ of the ſame homogeneous Fire; ſo that it was no Wonder that ‘ the Fiſhes breathed nearly as free in the Water, as though it ‘ had never been boiled nor under the Air-pump, particularly ‘ after they had been in it ſome ſmall Time.”

'Mouths and Gills, or Reſpiration, if I may 'call it ſo, differing from the Fiſhes in the 'other Glaſſes; the included Fiſhes at the 'ſame Time diſcovering no Alteration; only 'I took Notice that they would now and then 'aſcend to the Top of the Water, but ſud'denly ſwim down again: And in this State 'they continued for ſome conſiderable Time, 'without any ſenſible Alteration. About five 'Hours after the laſt Obſervation, the Fiſhes 'in the exhauſted Water became not ſo active '(upon a Motion given to the Glaſs which 'contained them) as before: And thoſe Gud'geons included without any Communication 'with the outward Air, now began conſider'ably to abate of their Vivacity; yet ſtill con'tinued, at Times, their Motion upward and 'down again. At ſeven in the Evening, the 'included Fiſhes lay all at the Bottom of the 'Glaſs with their Bellies upwards; nor, upon 'ſhaking the Glaſs, could I ſet them in Mo'tion, or cauſe them to ſtir their Fins or 'Tails; only I could obſerve a Motion in their 'Mouths, which ſhewed they were not per'fectly dead. In this State they lay for ſome 'Time: But conſidering the Experiment 'would not be complete, if I did not attempt 'their Recovery by taking off the braſs Co'ver, being very ſure they muſt have died in 'ſome ſmall Time, under the Circumſtances 'they were then in; accordingly I took off 'the Cover, and gave the Surface of the Wa-

'ter a free and open Communication with the 'external Air. At about ten at Night, I 'obſerved them again, at which Time their 'Recovery was ſo evident, that, upon a little 'diſturbing the Glaſs that contained them, they 'were actually in Motion again: And at this 'Time alſo, the Fiſhes in the Water purged of 'its Air, began to appear more briſk and lively 'than at the laſt Obſervation. Here I cannot 'but take Notice, that notwithſtanding the 'Water was purged of its Air to a very great 'Degree, yet the Fiſhes put into it did not ſo 'much as once aſcend in it; but continued 'always at the Bottom, as the Fiſhes did in 'the common Water. At this Time I left 'them till the next Morning; when, about 'eight o'Clock, I found them as perfectly well 'and lively in all the Glaſſes, as when they 'were firſt put in. Thoſe in the common 'Water expoſed to the open Air, ſuffered no 'Manner of Change during the whole Time. 'After this, I was willing to try whether the 'Air had again inſinuated itſelf into the 'purged Water, and whether that might not 'be the Occaſion of the Fiſhes Recovery. 'Accordingly I put it on the Plate of my 'Pump in the ſame Glaſs, with the Fiſhes 'in it; and being covered with another Re-'ceiver, the Air was taken from it; yet I 'could perceive very little Air aſcend in it, 'and to me it ſeemed much in the ſame State 'as when the Fiſhes were firſt put in. I con-

'tinued it *in Vacuo* about an Hour and an 'Half: The Fiſhes almoſt all the Time con'tinued at the Top of the Water; and at that 'Time appeared as dead; for upon letting in 'the Air, they ſunk haſtily to the Bottom 'without any Motion of their Fins or Tails.'

"From the whole Account I obſerve:—'*Firſt*, That Water purged of Air ſo far as 'the Method here made Uſe of is capable 'to do it, renders it not altogether unfit to 'ſupport the Lives of Water Animals. For 'although when the Fiſhes were firſt put in, 'and for ſome Hours after, they ſeemed to 'ſuffer ſome Uneaſineſs; yet at length the 'Water became more familiar to them, or 'their Conſtitutions in ſome meaſure did ſo 'conform, as to render the Water to them, 'and them to the Water, more agreeable. 'Otherwiſe I do not ſee how their Recovery 'ſhould follow; ſince, upon examining, little 'or no Alteration could be found in the Cir'cumſtances of the Water, from the Time 'the Fiſhes were firſt put in."

"*Secondly*, The Fiſhes included with their 'Water from any Communication with the 'external Air, plainly demonſtrate, that 'common Water in its natural State is not 'alone ſufficient to preſerve the Lives of its 'natural Animals. Hence, it follows, that 'in Ponds, when the Water comes to be 'frozen over with a pretty thick Ice, the 'Fiſhes in the ſaid Ponds are very likely, if 'not certain, to periſh, upon the Continuance 'of ſuch a Congelation for ſome Time on 'their Surfaces; unleſs (as in the latter Part 'of the Experiment) the Impediment which 'hindered the immediate Contact of the Air 'to the Surface of the Water, be removed; 'that is, by breaking Holes in the Ice, 'whereby it is reſtored, and undoubtedly 'will perform the ſame Thing as my Removal 'of the braſs Plate. This is to be under'ſtood only in Ponds, where the Water is 'ſtagnant; for where there are Springs, or a 'Current of Water conſtantly ſucceeding un'der the Ice; the Effect, moſt likely, will 'not be the ſame."

Remark.—Can any thing be more plainly proved by Experiment than the Vivifying Quality in Air? How ſoon were the Gudgeons in the ſecond Glaſs juſt on the Point of expiring for Want of a Communication with the external Air; and how ſoon revived at the Admiſſion of it? Who, unleſs he was *quite* a Sceptic, can read the Experiment and not be convinced of the Vivifying Quality in that Element?

B. What was his next Objection?

A. "A clear glaſs Jar of fair Water was 'put under the Receiver of an Air-pump; 'where the Exhauſtion was no ſooner begun, 'but the little expanſive Particles were plainly 'ſeen to riſe and eſcape through the Body of 'the Water to the Surface all the Time of the 'Exhauſtion."

His whole Reply to which, is:——"No "Proof that this is electric Matter." (*a*)

I had alluded to Sir *Iſaac Newton*'s ſecond general Rule of Reaſoning in Philoſophy, *viz. To the ſame Effects we muſt as far as poſſible aſſign the ſame Cauſe*; the magnetic Virtue which moves the Iron and Steel Filings beyond the Glaſs, and the Pneuma or electrical Virtue, juſt diſcovered, which moves the Feather, Leaf Gold, Leaf Braſs, &c. ſo vigorouſly beyond the Glaſs, muſt be the ſame identical ſubtile Agent, acting in different Conditions and Forms. I beg therefore this Rule may be particularly attended to; ſince many phyſical Experiments will be greatly illuminated by conſidering it attentively, which would otherwiſe ſeem much more abſtruſe and unintelligible.

Objection.—"*Newton*'s is a dangerous Rule. "We are too apt to generaliſe Facts; it is "pleaſing to the Mind ſo to do, but it is de-"ſtructive to Knowledge."

This Philoſopher, like many others, ſeems to make a downright Stalking-horſe of Sir *Iſaac Newton*, ſince, like a mere Noſe of Wax, he can put him on and off at Pleaſure. —I can however with great truth affirm, that this is the firſt Time I ever heard any of Sir *Iſaac*'s Rules ſo decried.

(*a*) **Since the Gentleman objects that it is no Proof that the Air riſing out of the Water was electric Matter, I ſhould be glad to be informed *what* it is? ſince Water is by no means permeable by the common Air.**

Eſſays, ſect. 129, 131, &c. Is concerning the Analogy between the Microcoſm and Macrocoſm.——This Analogy he treats with the utmoſt Contempt; and replies, " It will not " be allowed; it is a mere Dream, unworthy " of a Philoſopher, and ſeems alike in nothing " but the Sound of the two Words, *Microcoſm* " and *Macrocoſm: The* Barber'*s* Baſon *and* " Mambrino'*s* Helmet *were more alike*, which " furniſhed ſuch curious Matter of Specula- " tion to *Don Quixote*."

So keen a Sarcaſm, thrown out againſt me, by a particular Friend, was what I had no Reaſon to expect; but I can diſarm it of its Sting by the ſingle Remark of a judicious Critic, who was ſo pleaſed with the Analogy, that he ſaid a more juſt Compariſon was hardly to be met with: Microcoſm *and* Macrocoſm *being, in his Opinion, as much alike, as a Silver Penny is to a Five-ſhilling Piece*; both bearing the ſame Stamp, and differing only in Size.

B. I think your Friend has ſhewn his wit at the Expence of his judgment, and let him enjoy his dear-bought Purchaſe: But let us proceed.

A. He further affirms it to be " demon- " ſtrable that the elaſtic Air, diſcovered to " exiſt in the Pores of groſs Bodies, is very " different from electric Matter," although the direct contrary of this Aſſertion appears moſt evident: Therefore the Objection can never be admitted without Proof.

Eſſays, Part 3d, ſect. 181. *Martin*'s Experiment, he ſays, proves only that there is Air contained in theſe Subſtances, in an elaſtic ſtate:
“ It does by no means prove that the greateſt
“ Quantity of Air produced by Dr. *Hales*' Ex-
“ periments was not in a fixed ſtate *as a Part*
“ *of the Subſtance of the Body* operated upon;
“ (*a*) and there is no doubt but a Body, after
“ having all its elaſtic Air extracted by the Air-
“ pump, would ſtill yield nearly the ſame
“ Quantity of Air mentioned in the Doctor's
“ Experiment.”

In Part 3d, chap. 11th, of my Eſſays, are contained two Experiments of that celebrated Writer Dr. *Hales*, who fancied he could, by Fermentation, Diſtillation, &c. metamorphoſe ſolid Bodies into Air.—Among many others,

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(*a*) Here it is plain, that my Friend was credulous enough to think with Dr. Hales, that Part of the groſs Subſtance itſelf was metamorphoſed into Air.

When the Doctor made thoſe Experiments, he had never ſeen *any* which proved that a moſt exquiſitely rare, elaſtic, and pure Air exiſted in the Pores of groſs Bodies; otherwiſe it is preſumed he would never have broached ſo wild and inconſiſtent a Doctrine: Whereas my Friend, being an accurate Electrician, was not neceſſarily ignorant of this, as the Doctor was, and therefore the leſs excuſable.

A Letter of Encomium was ſent me 150 Miles, containing, among many other Things, the following Obſervation on that particular Subject. ——“ I thank you too for the Attention you
“ have beſtowed on that wild modern Subject the *Generation of*
“ *Air*, to which I could never be reconciled, and always imagined
“ the Fact to be as you have explained it.”

the two particular Bodies whereon the Experiments were made, were the human Calculus and 54 cubical Inches of Brandy: One half of the Weight of the former was converted into what he calls his artificial Air; whereas the latter afforded very little. The Reaſon I aſſigned for this was as follows.

The ſubtile Spirit, or pure Air, contained in the Pores of thoſe Bodies before their Diſſolution, does, when analyzed into their firſt Principles, naturally mix and incorporate with thoſe minute Particles of groſs Matter, in a ſimilar Manner as when in their original State; and thus an artificial Air is generated, as elaſtic and ponderous, and in moſt other reſpects the ſame as common Air; conſequently as permanent as that.—The eaſier the Body is diſſolved, and the more free the terreſtrial Corpuſcles riſe in the Diſtillation, the greater is the Quantity of *what* he calls the *new generated Air*. p. 387, ſect. 190.

This ſeems to be the only Reaſon why ſo great a Quantity was generated when the human Calculus was diſtilled; one half of the Weight of the Stone was by this means volatiliſed and incorporated with the contained Æther. p. 387, ſect. 191.

This appears likewiſe to be confirmed, by conſidering a quite different and contrary Deception which happened, when the Maſs to be analyzed contained almoſt the greateſt Quantity of the pure elementary Air or Spirit, and very little groſs Matter. p. 387, ſect. 192.

In Experiment 66, Vol. I. Dr. *Hales* found very little Air in 54 cubic Inches of Brandy; Had it been a highly rectified Spirit, he would have found none; all would have eſcaped; there being no groſs Matter to riſe and incorporate with it to prevent it. p. 387, ſect. 193.

Hence it comes to paſs, that when there is contained in the Maſs to be analyzed the greateſt Quantity of all of the pure, ſubtile, elementary Air, that no artificial Air can then be formed. Rectified Spirits of Wine ſeem, as it were, the pure Air or Fire in a liquid Form. p. 388, ſect. 194.

To this he ſneeringly replies, "Is Sir *Iſaac* "*Newton*'s Æther then come at laſt to be "rectified Spirit of Wine? And is Alcohol "and Electricity the ſame Thing?"

I anſwer, it is, and for the fore-mentioned Reaſons, *i. e.* when reduced to ſuch a liquid Form: And whoever denies it, will be expected to ſhew a more plauſible one, why the human Calculus yielded ſo great a Quantity of elaſtic Air; and why almoſt a Quart of Brandy yielded ſo very little.

N. B. He made many more Objections, tho' not one that contained any thing remarkable. His Apology for not giving Reaſons for the Objections he makes is, that it would be too much for the Compaſs of a Letter; which is thought but a ſlender Apology for giving no Reaſons for hardly any of them; at leaſt, not any that were ſupported with either Experiments or Arguments.

Having gone over the moſt material Objections which that Gentleman has made to my Eſſays, and finding them incapable of overturning my Poſitions, I muſt beg Leave to add, that wherever I am wrong in my Principles, or Deductions from them, it would give me the ſincereſt Pleaſure to be ſet right by any ſagacious Enquirer, who is capable of affording me better Information.

It is much to be wiſhed that a friendly Conference was carried on by the Channel of ſome one of the periodical Papers, in order to ſettle philoſophical Points, particularly ſuch as are moſt doubtful.——We might then, with Eaſe and Preciſion, attempt to diſcuſs even the very Fundamentals of Philoſophy, and not without ſome reaſonable Hope of Succeſs: I mean, we might then paſs a ſtrict and juſt Scrutiny upon thoſe grand Articles in Diſpute, at which even the moſt learned Men ſo grievouſly ſtumble; *viz.* whether an *univerſal Vacuum* exiſts, or an *univerſal Plenum.* For when once that is ſatisfactorily ſettled, we ſhould no longer halt between two ſuch contradictory Opinions. If ſuch an amicable Conference as abovementioned was earneſtly and properly purſued by Way of *pro* and *con*, the moſt doubtful Caſes would be brought to an Iſſue; ſince then it muſt ſoon appear on which Side the cleareſt and ſtrongeſt Evidence lies.

DIALOGUE X.

Dr. Prieſtley *upon the Univerſality of the electrical Phenomena -- Water-Spouts. A particular Hurricane.--He imitates an Earthquake.--What he terms Natural Electricity.--Dr.* Henry More*'s Hylarchic Principle defined.*

B. WHO among the Moderns is looked upon as the greateſt Advocate for electrical Philoſophy, and the great Power and Force of the electrical Fire?

A. None can plead much more ſtrenuouſly for thoſe Things, nor for the Univerſality of the Fire, than the ingenious Dr. *Prieſtley*, who informs his Readers of a Variety of abſtruſe Phenomena of Nature, which much perplexed the Philoſophers, ſince they could never account for them in a ſatisfactory Manner: Phenomena in the Heavens, in the Earth, and in the Sea: *viz.* Aurora Borealis, Lightning, Falling-Stars, Fire-Drakes, Fire-Balls, and other Meteors.—Whirlwinds, Inundations, Hurricanes, Water-Spouts, *&c.* and even Earthquakes: All which are now, with great Reaſon, ſuppoſed to be Effects of this grand Agent, the electrical Fire.

The Doctor ſays, that "the Aurora Borealis being an electrical Phenomena was, he believes, never doubted from the Time that Lightning was proved to be one."

He takes Notice, that "the Meteor, hitherto called a Falling-Star, has puzzled all Philoſophers."

"Signor *Beccaria*," (*a*) he ſays, "makes it pretty evident that it is an electrical Appearance; and the Fact which he relates as a Proof of it, is exceedingly curious and remarkable. He informs us that, As he was ſitting with a Friend in the open Air, an Hour after Sun-ſet, they ſaw what is called a Falling-Star directing its Courſe towards them, and apparently growing larger and larger till it diſappeared not far from them; when it left their Faces, Hands, and Cloaths, with the Earth, and all neighbouring Objects, ſuddenly illuminated with a diffuſed and lambent Light, attended with no Noiſe at all.—While they were ſtanding up, ſtaring and looking at each other, ſurpriſed at the Appearance, a Servant came running to them out of a neighbouring Garden, and aſked them if they had ſeen nothing; for that he had ſeen a Light ſhine ſuddenly in the Garden, and eſpecially upon the Streams which he was throwing to Water it."

(*a*) An Italian Electrician.

Dr. *Prieſtley*, at p. 352, ſays, that " Appear‑
' ances which bear evident Marks of Electri‑
' city, have a very ſenſible progreſſive Motion,
' is demonſtrated from a Variety of meteoro‑
' logical Obſervations. I ſhall relate one made
' by Mr. *Chalmers*, when he was on board the
' *Montague*, under the Command of Admiral
' *Chambers*."

" On the 4th of November, 1749, in Lat.
' 42° 48′, Long. 9° 3′, he was taking an Ob‑
' ſervation on the Quarter-deck, about ten
' minutes before 12, when one of the Quarter-
' Maſters deſired he would look to the Wind‑
' ward; upon which he obſerved a large Ball of
' blue Fire rolling on the Surface of the Water,
' at about three Miles diſtant from them. They
' immediately lowered their Top-ſails, &c. but
' it came down upon them ſo faſt, that before
' they could raiſe the Main-tack, they obſerved
' the Ball to riſe almoſt perpendicular, and not
' above forty or fifty Yards from the Main-
' chains; when it went off with an Exploſion
' as if hundreds of Cannon had been fired at one
' Time, and left ſo great a Smell of Brimſtone,
' that the Ship ſeemed to be nothing but Sul‑
' phur. After the Noiſe was over, which he
' believed did not laſt longer than half a ſecond,
' they found their Main Top-maſt ſhattered
' into above an hundred Pieces, and the Main-
' maſt rent quite down to the Heel. There
' were ſome of the Spikes which nail the Fiſh
' of the Main-maſt, drawn with ſuch Force

'out of the Maſt, and they ſtuck ſo faſt in the 'Main-deck, that the Carpenter was obliged 'to take an Iron Crow to get them out. There 'were five Men knocked down, and one of 'them greatly burnt by the Exploſion. They 'believed, that when the Ball, which appeared 'to them to be of the Bigneſs of a large Mill-'ſtone, roſe, it took the Middle of the Main 'Top-maſt, as the Head of the Maſt, above 'the Hounds, was not ſplintered."

Dr. *Prieſtley* informs us, that "The fore-'mentioned Signor *Beccaria* takes ſome Pains 'to ſhew that Water-Spouts have an electric 'Origin. To make this more evident, he firſt 'deſcribes the Circumſtances attending their 'Appearance; which are the following."

"They generally appear in calm Weather; 'the Sea ſeems to boil and ſend up a Smoak 'under them, riſing in a Hill towards the 'Spout; at the ſame Time Perſons who have 'been near them have heard a rumbling Noiſe. 'The Form of a Water-Spout is that of a 'Speaking-trumpet, the wider end being in the 'Clouds, the narrower end towards the Sea. 'The Size is various, even in the ſame Spout. 'The Colour is ſometimes inclining to white, 'and ſometimes to black. Their Poſition is 'ſometimes perpendicular to the Sea, ſometimes 'oblique, and ſometimes the Spout itſelf is in 'the Form of a Curve. Their Continuance is 'very various, ſometimes diſappearing as ſoon 'as formed, and ſometimes continuing a con-

'ſiderable Time; One that he had heard of, 'continued a whole Hour; but they often vaniſh, and preſently appear in the ſame Place."

"What Water-Spouts are at Sea, the ſame 'are ſome Kinds of Whirlwinds and Hurri-'canes by Land: They have been known to 'tear up Trees, to throw down Buildings, 'make Caverns in the Earth; and in all theſe 'Caſes to ſcatter Earth, Bricks, Stones, Tim-'ber, *&c.* to great Diſtances in every Direc-'tion. Great Quantities of Water have been 'left or raiſed by them, ſo as to make a kind 'of Deluge; and they have been always at-'tended with a prodigious rumbling Noiſe."

"That theſe Phenomena of Water-Spouts, '*&c.* depend upon Electricity, cannot but ap-'pear very probable from the Nature of ſeveral 'of them; but the Conjecture is made more 'probable from the following additional Cir-'cumſtances. They generally appear in months 'peculiarly ſubject to Thunder-ſtorms, and are 'commonly preceded, accompanied, or fol-'lowed by Lightnig, Rain, or Hail, the pre-'vious ſtate of the Air being ſimilar. Whitiſh 'or yellowiſh Flaſhes of Light have ſometimes 'been ſeen moving with prodigious Swiftneſs 'about them. And laſtly, the manner in which 'they terminate exactly reſembles what might 'be expected from the Prolongation of one 'of the uniform Protuberances of electrical 'Clouds towards the Sea, the Waters and the 'Cloud mutually attracting each other; for 'they ſuddenly contract themſelves and diſ-'perſe almoſt at once, the Cloud riſing, and 'the Water of the Sea under it falling to its 'Level. But the moſt remarkable Circum-'ſtance, and the moſt favourable to the Sup-'poſition of their depending upon Electricity, 'is, that they have been diſperſed by preſenting 'to them ſharp pointed Knives and Swords. 'This, at leaſt, is the conſtant Practice of the 'Mariners in many Parts of the World where 'theſe Water-Spouts abound; and he was 'aſſured by ſeveral of them, that the Method 'had often been undoubtedly ſucceſsful."

B. To Signor *Beccaria*'s Theory of Water-Spouts and Hurricanes, Dr. *Prieſtley* adds a Deſcription of a Hurricane in the Weſt Indies.

A. We have frequent Accounts of ſuch dreadful Hurricanes in America, from which moſt other Parts of the known World are happily exempted —It is in a rainy Seaſon, principally in the Month of Auguſt, that they are aſſaulted by Hurricanes the moſt terrible, to which they are ſubject from the Climate.

"This Calamity deſtroys at one ſtroke the 'Labours of many Years, and fruſtrates the 'moſt exalted Hopes of the Planter; and often 'juſt at the Moment when he thinks himſelf 'out of the Reach of Fortune.—It is a violent 'Storm of Wind, Rain, Thunder, and Light-'ning, attended with a furious ſwelling of the 'Sea, and ſometimes with an Earthquake; in 'ſhort, with every Circumſtance which the

'Elements can aſſemble that is terrible and 'deſtructive."

"Firſt they ſee, as a Prelude of the enſuing 'Havock, whole Fields of Sugar-canes whirled 'into the Air, and ſcattered over the Face of 'the Country. The ſtrongeſt Trees of the 'Foreſt are torn up by the Roots, and driven 'about like Stubble. Their Windmills are 'ſwept away in a Moment. Their Works, the 'Fixtures, the ponderous Copper Boilers, and 'Stills of ſeveral hundred weight are wrenched 'from the Ground, and battered to Pieces. 'Their Houſes are no Protection: The Roofs 'are torn off at one Blaſt; whilſt the Rain, 'which in an Hour riſes five Feet, ruſhes in 'upon them with an irreſiſtible Violence."

The Hiſtorian informs us, that "Dr. *Stukely* 'was of opinion that Earthquakes were the 'probable Effects of electrical Fire, upon the 'Occaſion of the two Earthquakes in February 'and March, 1749; and another in North'amptonſhire, in September, 1750. The Pa'pers which he delivered to the Royal Society 'on theſe occaſions, which were read in March, '1749, and December, 1750," Dr. *Prieſtley* ſays, "are valuable, and well deſerve the At'tention of all Philoſophers and Electricians."

"That Earthquakes are not owing to ſub'terraneous Winds, Fires, Vapours, or any 'thing that occaſions Exploſions, and heaves 'up the Ground, he thought might eaſily be 'concluded from a Variety of Circumſtances.

'In the firſt Place, he thought there was no 'remarkable evidence of any cavernous ſtructure of the Earth; but that, on the contrary, 'there is rather Reaſon to preſume that it is in 'a great Meaſure ſolid, ſo as to leave little 'room for internal Changes and Fermentations 'within its ſubſtance; nor do Coal-pits," he ſays, "when on Fire, ever produce any thing 'reſembling an Earthquake."

"It is not," he ſays, "upon the Principle of 'any ſubterraneous Exploſion, that we can, in 'the leaſt, account for the Manner in which 'Ships, far from any Land, are affected during 'an Earthquake; which ſeems as if they ſtruck 'upon a Rock, or as if ſomething thumped 'againſt their Bottoms: Even the Fiſhes are 'affected by an Earthquake. This ſtroke 'therefore muſt be occaſioned by ſomething 'that could communicate Motion with unſpeakably greater Velocity than any heaving 'of the Earth under the Sea by the Elaſticity 'of generated Vapours: This could only produce a gradual ſwell, and could never give an 'Impulſe to the Water ſo as to make it feel 'like a Stone."

"The Impreſſion made by an Earthquake 'by Land and Water, to the greateſt diſtances, 'is obſerved to be inſtantaneous; which could 'only be effected by Electricity. In the Earthquake in September, the Concuſſion was felt 'thro' a ſpace of 100 Miles in Length and 40 'in Breadth, and, as far as could be judged, at the ſame Inſtant of Time. That this Tract of Land, which amounted to 4000 ſquare Miles in Surface, ſhould be thrown into ſuch an Agitation in a Moment, is ſuch a Prodigy," the Doctor ſays, "as we could never believe or conceive, did we not know it to be fact from our Senſes. But if we ſeek the ſolution of it, we cannot think any natural Power equal to it, but that of Electricity, which acknowledges no ſenſible Tranſition of Time, no Bounds!"

"The little Damage generally done by Earthquakes, the Doctor thought to be an Argument of their being occaſioned by a ſimple Vibration or tremulous Motion of the Surface of the Earth, by an electrical Snap. This Vibration," he ſays, "impreſſed on the Water, meeting with the ſolid Bottoms of Ships and Lighters, occaſions that Thump which is ſaid to be felt by them; yet of the Millions of ordinary Houſes that it paſſed over, not one fell. A Conſideration which ſufficiently points out, what ſort of Motion this was not, alſo what ſort of Motion it was, and whence derived: Not a Convulſion in the Bowels of the Earth: but an uniform Vibration along its Surface, like that of a muſical String, or what we put a Drinking-glaſs into by rubbing one's Finger on the edge, which yet, being brought to a certain Pitch, breaks the Glaſs; undoubtedly," he adds, "an electrical Repulſion of its Parts."

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"That Earthquakes are electrical Phenome-
'na is further evident," he ſays, "from their
'chiefly affecting the Sea-coaſts, Places along
'Rivers, and, I may add, Eminences. The
'Earthquake in September ſpread moſtly to the
'North and South, which," the Doctor ſays,
'is the direction of the Spalding River; where-
'by it was conveyed to the Sea-ſhore, where it
'was particularly ſenſible; thence up Boſton
'Channel, and ſo up Boſton River to Lincoln.
'The greateſt Part of this Earthquake diſ-
'played its Effects along and between the two
'Rivers Welland and Avon; and that from their
'Sources down to their Mouths: It likewiſe
'reached the River Witham, which directed
'the electrical Stream that way alſo to Lincoln;
'for which reaſon, meeting the ſame coming
'from Boſton, it was moſt ſenſibly felt there.
'It reached likewiſe to the Trent at Notting-
'ham, which conveyed it to Newark."

"The firſt electrical Stroke in this Earth-
'quake ſeemed to the Doctor to have been
'made on the high Ground about Daventry in
'Northamptonſhire. From thence it deſcended
'chiefly eaſtward, and along the River Wel-
'land, from Harborough to Stamford, Spalding,
'and the Sea; and along the Rivers Avon and
'Nen to Northampton, Peterborough, Wiſbich,
'and the Sea: It ſpread itſelf all over the vaſt
'Level of the Iſle of Ely, prombted by a great
'number of canals, natural and artificial, made
'for draining that Country. It was ſtill con-

'ducted eaſtward by Mildenhall River, in Suffolk, to Bury and the Parts adjacent. All 'theſe Circumſtances, duly conſidered, were 'to him a Confirmation of the Doctrine he 'advanced on that ſubject.

"It muſt ſeem very ſurpriſing and unaccountable to Perſons unacquainted with Electricity, that all this could be performed in the 'leaſt inſtant of Time, notwithſtanding it was 'conducted to, and touched at ſo many different Places. However, the ſagacious Experimentaliſt is well aſſured that this is a moſt undoubted truth; and our electrical Experiments are manifeſt Proofs, that the progreſſive 'Motion of the Fire is ſo inſtantaneous, as not 'to admit of the leaſt ſenſible tranſition of Time 'in its paſſage even to the moſt diſtant parts."

According to Dr. *Prieſtley*, not only Dr. *Stukely*, but the renowned Dr. *Hales*, Mr. *Hartman*, and others, were of Opinion, that Earthquakes were electrical Phenomena.

The Doctor obſerving the electrical Fire from his Battery to paſs over the ſurface of the Water (*a*) in order to arrive at his braſs Rod, ſays, "The Reſemblance of the electric Matter over 'the ſurface of the Water, and that which Dr. '*Stukely* ſuppoſed to ſweep the ſurface of the 'Earth, when a conſiderable Quantity of it is 'diſcharged to the Clouds during an Earthquake, immediately ſuggeſted to him, that

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(*a*) See his Hiſtory of Electricity, p. 649.

'the Water in his Experiment over which the 'electrical Fire paſſed, and which was viſibly 'thrown into a tremulous Motion thereby, 'muſt receive a Concuſſion reſembling that 'which is given to the Waters of the Sea on 'ſuch an Occaſion."

"To try this," he ſays, "myſelf and ſeve'ral other Perſons who were preſent, put our 'Hands into the Water, when an electric 'Flaſh, as before, paſſed over its ſurface; and 'we felt a ſudden Concuſſion given to them, 'exactly like that which is ſuppoſed to affect 'Ships at Sea during an Earthquake."

B. Theſe are moſt wonderful Accounts indeed! as well as entertaining: Pray what is the next thing we are to conſider?

A. I ſhall furniſh you with ſome further Obſervations of the ſame ingenious Author, who, at p. 370, ſays, "I ſhall cloſe this account 'of the Theory of Lightning, and other Phe'nomena of the Atmoſphere, with an Enume'ration of the principal Appearances of *natural* 'Electricity obſerved by the Antients; and 'which were never underſtood before the Diſ'covery of Dr. *Franklin.* It will be very eaſy 'for me to do this, as I find them already 'collected to my Hands by Dr. *Watſon.*" (*a*)

"A luminous Appearance, which muſt have 'been of an electrical Nature, is mentioned by '*Plutarch* in his Life of *Lyſander.*"

(*a*) Philoſoph. Tranſact. Vol. 48, Exp. 1ſt, p. 210.

" *Pliny*, in his 2d Book of Natural Hiſtory, ' calls thoſe Appearances Stars; and tells us, ' that they ſettled not only upon the Maſts and ' other parts of ſhips, but alſo upon men's heads."

" Stars make their Appearance both at land ' and ſea. I have ſeen a Light in that Form on ' the ſpears of ſoldiers, keeping Watch by ' Night on the Ramparts. They are ſeen alſo ' on the ſail-yards and other parts of ſhips, ' making an audible ſound, and frequently ' changing their Places. Two of theſe Lights ' forebode good Weather, and a proſperous ' Voyage; and drive away one that appears ' ſingle, and wears a threatening Aſpect. This ' the ſailors call Helen, but the two they call ' Caſtor and Pollux, and invoke them as Gods. ' Theſe Lights do ſometimes, about the Evening, ' reſt on Men's Heads, and are a great ' and good Omen. But theſe are among the ' awful Myſteries of Nature."

" *Seneca*, in his Natural Queſtions, chap. 1, ' takes Notice of the ſame Phenomena.——A ' Star ſettled on the lance of *Gylippus*, as he was ' ſailing to Syracuſe; and ſpears have ſeemed ' to be on Fire in the Roman Camp."

" About that Time there was a very extra' ordinary Appearance in the Army of *Cæſar*. ' In the Month of February, about the ſecond ' Watch of the Night, there ſuddenly aroſe a ' thick Cloud, followed by a ſhower of ſtones; ' and the ſame Night, the Points of the ſpears ' belonging to the Fifth Legion ſeemed to take ' Fire."

" The Spears of ſome Soldiers in Sicily, ' and a walking Stick, which a Horſeman in ' Sardinia was holding in his Hand, ſeemed to ' be on Fire. The Shores were alſo luminous ' with frequent Fires."

" Theſe Appearances are called both by the ' French and Spaniards inhabiting the Coaſts of ' the Mediterranean Sea, St Helme's or St. ' Telm's Fires; by the Italians, the Fires of St. ' Peter and St. Nicholas." And are frequently taken Notice of by the Writers of Voyages.

" If ſome late Accounts from France," adds the Doctor, " are to be depended on, this Phenomenon has been obſerved at Plauzet for time ' immemorial, and M. *Binon*, the Cure of the ' Place, ſays, that for twenty-ſeven Years, ' which he had reſided there, in great Storms ' accompanied with black Clouds and frequent ' Lightnings, the three pointed Extremities of ' the Croſs of the Steeple of that Place appeared ſurrounded with a Body of Flame; ' and that when this Phenomenon has been ' ſeen, the ſtorm was no longer to be dreaded, ' and calm weather returned ſoon after."

" Modern Hiſtory furniſhes a great Number ' of Examples of Flames appearing at the Extremities of pointed metallic Bodies, projecting into the Air. Little Notice was taken of ' theſe, while the Cauſe of them was unknown; ' but ſince their near Affinity with Lightning ' has been diſcovered, they have been more ' attended to and collected."

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Here it may be obſerved, that electrical Philoſophers are not ſingular in repreſenting the electrical Fire as an univerſal Principle: Dr. *Prieſtley* ſeems entirely of their Opinion, and ſuppoſes that all the Appearances which he had been enumerating were *electrical Phenomena*, that is, that they were effects of electrical Fire.

B. What do electrical Philoſophers think reaſonable to conclude from ſuch Appearances?

A. That from ſuch an ample Field, ſuch a vaſt Fund of indubitable Facts, they may ſafely conclude the electrical Fluid to be a general Agent, and an univerſal Principle in the ſtricteſt Senſe; ſince there was a great Variety of Appearances in Nature which ſeemed to point out ſuch a general active Agent or firſt inſtrumental Mover, too obvious to be overlooked by the moſt ſagacious Philoſophers of all Ages; many of whom, both antient and modern, ſeem by their Writings to have had very clear Glimpſes, and adequate Ideas of it, before it was actually diſcovered by modern Experiments, though diſtinguiſhed by different Appellations——as Fire, Anima Mundi, Subtile Medium or Æther, Materia ſubtilis, &c.—*Chambers* under the term Anima Mundi informs us, that ſome ſuppoſe Plato by his *Anima Mundi* to have meant God or the ſpirit of God, and to have taken the Hint from Moſes, who in his Account of the firſt Day's Creation, ſays, "*the* "*Spirit of God moved on the Face of the* "*Deep.*"

" The modern Platoniſts explain their Maſter's *Anima Mundi* by a certain univerſal ' æthereal Spirit, which in the Heavens exiſts ' perfectly pure, as retaining its proper nature; ' but, on Earth, pervading elementary Bodies, ' and intimately mixing with all the minute ' Atoms thereof, aſſumes ſomewhat of their ' Nature, and becomes of a peculiar Kind."

" They add, that this *Anima Mundi*, which ' more immediately reſides in the celeſtial Regions as its proper ſeat, moves and governs ' the Heavens in ſuch a Manner, as that the ' Heavens themſelves firſt received their Exiſtence from the Fecundity of the ſame Spirit: ' For that this *Anima* being the primary Source ' of Life, every where breathed a Spirit like ' itſelf; by virtue whereof various Things were ' framed conformable to the divine Ideas."

Sir *Iſaac Newton*'s ſubtile Medium or Æther exactly coincides with the *Anima Mundi* of the Platoniſts. The Carteſians have their ſubtile Matter, which anſwers to moſt of the Uſes and Intentions of the ſame Principle. The learned *Biſhop of Cloyne*, as well as many of the antient Philoſophers, ſubſtitute fire as the Anima Mundi, which appears to come neareſt of all to the electrical Philoſophy.—The Appellation, *Nature*, is explained much in the ſame Manner.

" The word Nature in a ſtrict Senſe is uſed ' for the Action of Providence, the Principle ' of all Things, or that ſpiritual Power or Being which is diffuſed throughout the Creation, 'and moves and acts in all Bodies, and gives 'them certain Properties and produces certain 'Effects." This is the Senſe which Mr. *Boyle* conſiders as the moſt uſual. "NATURE is 'nothing elſe but GOD, acting himſelf, and 'according to certain Laws, which he him'ſelf has fixed."

"This ſeems pretty agreeable to the Opi'nion of many of the Antients, who made 'Nature the God of the Univerſe, who pre'ſides over and governs all."

F. Mallebranche ſays, "the Nature ſo much 'talked of in the Schools is fit for nothing but 'to lead us back to Idolatry: The antient 'Heathens hereby underſtanding ſomething, 'which without being God, acts continually 'throughout the Univerſe. Thus the Idol '*Nature* muſt be an actual Principle which 'under God is the next and immediate Cauſe 'of all the Changes which befal Matter, which 'ſeems to fall in with the Opinion of the *Ani*'*ma Mundi*; as if *Nature* were a Subſtitute of 'God, or a collateral cauſe with God, or a mid'dle Being between God and created Things." Vide *Chambers* under the word Nature.

To theſe might be added, the learned Dr. *Henry More*'s Hylarchic Principle, or Univerſal Spirit of the World, which he thus defines:—

"A Subſtance incorporeal, but without Senſe 'and Animadverſion, pervading the whole 'Matter of the Univerſe, and exerciſing a plaſ'tical Power therein, according to the ſundry

'Prediſpoſitions and Occaſions in the Parts it
'works upon; raiſing ſuch Phenomena in the
'World, by directing the Parts of the Matter
'and their Motion, as not to be reſolved into
'mere mechanical Powers." (*a*)

DIALOGUE XI.

On MOTION.

Different Opinions concerning Motion.----The Exiſtence of it denied.----Different and fallacious Methods made uſe of to prove the ſame, by Diodorus Cronus.----Zeno *and* Others *endeavouring to prove that* Achilles, *tho' ever ſo ſwift, could never overtake a* Tortoiſe, *altho' the ſloweſt of Animals.*----Dr. Keil,---Mr. Rowning,---Des Cartes, *and* Dr. Stevenſon'*s Sentiments on Motion.*

B. HOW do modern Philoſophers account for the Origin of Motion?

A. The Cauſe of Motion in the World has been much controverted, and eſteemed one of the moſt abſtruſe

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(*a*) See his Treatiſe, Book 3d, chap. 12, p. 193.

Phenomena. Many eminent Philoſophers have made much Enquiry concerning its Nature, and taken great Pains to ſhew whence it proceeds. Some ſuppoſe it to be a Principle or Property inherent in Matter or Body itſelf: whilſt others are of Opinion, that it is a created Eſſence, diſtinct from Matter, and acts as a Cauſe. Many other wild and incoherent Notions of it, have been at different Times maintained, all of which ſeem owing to the perplexed ſtate the Subject was neceſſarily involved in: Neceſſarily I ſay, it being next to impoſſible to form any adequate Idea of the Cauſe of Motion, before Fire was diſcovered, by means of the electrical Apparatus, to be a permanent durable Principle.

B. How do modern Philoſophers account for the Cauſe of Motion?

A. Dr. *Keil*, in the 6th Lecture of his Introduction to Natural Philoſophy, p. 68, edit. 2d, when ſpeaking of Motion, calls it "the nobleſt ' *Affection* that Body is endued with; (*a*) by ' the Mediation whereof, Nature diſcovers her- ' ſelf acting in that Variety of Things which ' ought not to be beheld without Wonder and ' Aſtoniſhment; and without which all the ' Ornament and Beauty in the World would ' periſh, and a horrid Darkneſs and an infinite ' Numbneſs would poſſeſs every thing. On this

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(*a*) Here it is plain Dr. Keil was of Opinion, that Motion was a Property or Quality inherent in Matter.

‘ depend the Viciſſitudes of Days and Nights, ‘ and the ſo great Variety of Cold and Heat, ‘ Snow, Rain, and Sun-ſhine, ſucceeding each ‘ other, and all the Seaſons of the Year. By ‘ Motion, Plants grow, Trees are nouriſhed, ‘ and Animals live; ſince Life itſelf conſiſts ‘ only in Motion, that is, the Circulation of ‘ the Blood. But why do I ſpend Time in ‘ enumerating Particulars, ſince all Things ‘ owe their Birth to Motion.

“ The Science therefore of Motion is ſo ne‘ceſſary to philoſophize aright, that not the ‘ leaſt Operation of Nature can be inveſtigated ‘ without it. Hence the famous and moſt true ‘ Saying of the Philoſopher, *Motion being un‘known, Nature muſt of neceſſity be ſo likewiſe.*”

“ The Philoſophers, or rather Metaphyſi‘cians, have had various Diſputes concerning ‘ the Nature, Cauſes, and Communication of ‘ Motion; and the Confuſion of Ideas, and the ‘ Darkneſs that thence aroſe, appear to have ‘ been ſo great, that amongſt the Follies of ‘ Diſputation, the natural and ſimple Notion ‘ that they had of it, ſeems to have been loſt ‘ amongſt them. For there can ſcarce be found ‘ one of the common People, or the meaneſt ‘ Artificer, but he knows more of the true ‘ *Nature* and *Cauſe* of Motion, than all theſe ‘ wrangling Philoſophers together; ſome of ‘ whom were arrived to that Height of Folly, ‘ as to deny all Motion, as a Thing impoſſible ‘ to Bodies; and they propoſe ſome Cavils,

‘ whereby they flatter themſelves, that they ‘ have demonſtrated its Impoſſibility.”

“ We will produce here ſome of their ‘ ſtrongeſt Arguments; and the firſt ſhall be ‘ that of *Diodorus Cronus*, namely, If a Body ‘ moves, it muſt either move in the Place ‘ where it is, or in the Place where it is not; ‘ both which are impoſſible: For if it moves ‘ in the Place where it is, it will never depart ‘ from that Place, and ſo there will be no ‘ Motion: In like manner it cannot move ‘ where it is not, becauſe nothing acts in the ‘ Place where it is not; therefore a Body will ‘ not move at all. I anſwer, that a Body ‘ neither moves in the Place where it is, nor ‘ in the Place where it is not; but it moves ‘ from one Place to another.”

“ The ſecond Argument ſhall be that of ‘ *Zeno*, to which he gave the Name of *Achilles*; and therefore endeavours to prove, that, ‘ if there be any ſuch thing as Motion, *Achilles*, tho’ ever ſo ſwift, could never overtake a ‘ Tortoiſe, tho’ the ſloweſt of Animals. The ‘ Argument is this: Suppoſe *Achilles* to be ‘ diſtant from the Tortoiſe a certain finite ‘ Space, as for example, a Mile; and let us ‘ ſuppoſe he moves an hundred Times faſter ‘ than the Tortoiſe: Therefore whilſt *Achilles* ‘ runs one Mile, the Tortoiſe has moved the ‘ hundredth Part of a Mile; ſo that *Achilles* ‘ has not yet overtaken the Tortoiſe: And ‘ again, whilſt *Achilles* paſſes over that hundredth

dredth Part of a Mile, the Tortoiſe, in the mean while will have creeped thro' the ten thouſandth Part of a Mile; inſomuch that neither has *Achilles* yet overtaken the Tortoiſe: After the ſame manner, whilſt *Achilles* runs the ten thouſandth Part of a Mile, the Tortoiſe will have advanced forward the millionth Part of a Mile; ſo that *Achilles* has not yet come up with the Tortoiſe. And ſo he may go on *in infinitum*; nor will he ever be able to overtake the Tortoiſe; but there will always be ſome Diſtance between *Achilles* and the Tortoiſe."

" This is the famous Argument of *Zeno*; to anſwer which, ſome have written whole treatiſes: But we may eaſily diſſolve the Knot, by ſaying, that a Mile, together with the hundredth Part of a Mile, together with the ten thouſandth Part of a Mile, with the millionth Part of a Mile, and ſo on *in infinitum*, will be equal to a finite Quantity. For it is demonſtrated by the Arithmeticians, that the Sum of any Series of Quantities decreaſing in any geometrical Proportion *in infinitum*, will be equal to a finite Quantity; but the hundredth part of a Mile, together with the ten thouſandth part of a Mile, together with the millionth part, together with the hundred millionth part, and ſo on *in infinitum*, is a Series of Quantities, decreaſing in geometrical Proportion *in infinitum*: So that its Sum, ſince it is equal to a finite Quantity, may be

‘ run over by a Body moving with a given ‘ Velocity, in a finite Time. For let us ſup‘ poſe *Achilles* in the Space of an Hour to run ‘ a Mile, therefore he will paſs over the hun‘ dredth part of a Mile in the hundredth part ‘ of an Hour, and the ten thouſandth part of a ‘ Mile in the ten thouſandth part of an Hour; ‘ and after the ſame Manner he will move ‘ through the millionth part of a Mile in the ‘ millionth part of an Hour; and ſo of the reſt. ‘ If therefore one Hour, together with the hun‘ dredth part of an Hour, together with the ten ‘ thouſandth part of an Hour, together with ‘ the millionth part of an Hour, together with ‘ the hundred millionth part of an Hour, *&c.* ‘ *in infinitum:* If, I ſay, the Sum of the Series ‘ continued *in infinitum* is equal to an infinite ‘ Space of Time, it is certain *Achilles* would ‘ never overtake the Tortoiſe in any finite ‘ Space of Time: But ſince, as we ſaid before, ‘ the hundredth, ten thouſandth, millionth, ‘ *&c.* parts of an Hour, is a Series of Quantities ‘ decreaſing in geometrical proportion *in infini‘ tum*, its Sum will be equal to a finite Quantity, ‘ *viz.* the ninety-ninth part of an Hour, as ‘ might be demonſtrated; and within that ſpace ‘ of time, all the Particles of Time, however ‘ infinite in Number, will be paſſed. We ‘ ſay therefore, that *Achilles* will overtake the ‘ *Tortoiſe*, after one hour, and all thoſe Parti‘ cles of time, contained in the foregoing Series, ‘ and which are infinite in Number, are ex

‘ pired; that is, he will arrive at the Tortoiſe, ‘ after one Hour and the ninety-ninth Part of ‘ an Hour; and ſo the Force of this Argument ‘ is deſtroyed; though its Patrons have ſo often ‘ boaſted of it as unanſwerable.”

Thus the Dr. goes on haranguing and trifling with his Pupils about the word Motion; but never Attempts to make the leaſt Enquiry after its *Cauſe*, though he exclaims ſo much at others for not doing it. This Story of Achilles and the Tortoiſe put me in mind of another, which might have been propoſed, as bearing ſome affinity to it, though equally trifling, viz. If the hour and minute Indexes of a Clock were both of them to ſet out from the Hour 12, for according to their fallacious Method of arguing, the minute Index, although it moved 12 times faſter than the other, could yet never be able to overtake it. This Problem, like the other, would be found a Series of Numbers decreaſing in geometrical proportion.

As a Solution of this Problem may amuſe ſome Tyro’s, I ſhall take the Liberty of obliging them, and others, if they pleaſe, may paſs it over.

Firſt, Since in the Time that the minute Index moves 12 Hours, the hour Index moves but one hour, the proportion will be as 12 to 1; conſequently, as 12 : 1 :: 1 : $\frac{1}{12}$, and as 12 : 1 :: $\frac{1}{12}$: $\frac{1}{12}$ of $\frac{1}{12}$, and ſo on *in infinitum*; viz. a ſeries of quantities continually decreaſing in geometrical proportion.—*Secondly*, The moſt conciſe

Method of ſolving this Problem will be by ſpecious Arithmetic: The Proportion being as 12 is to 1; let $a=12$ and $b=1$, then as $a:b::b:\frac{bb}{a}$, and as $a:b::\frac{b_2}{a}:\frac{b^3}{a^2}$, and as $a:b::\frac{b^3}{a^2}:\frac{b^4}{a^3}$ and ſo is $\frac{b^4}{a^3}:\frac{b^5}{a^4}::\frac{b^5}{a^4}:\frac{b^6}{a^5}::\frac{b^6}{a^5}:\frac{b_7}{a^6}$, *&c.* a ſeries of Quantities decreaſing in geometrical proportion *in infinitum*.

Thirdly, If the Solution be performed by ſexagenary Arithmetic, the Series will be 1 Hour, 5 minutes, 27 ſeconds, 16 thirds, 21 4ths, 49 5ths, 5 6ths, 27 7ths, 16 8ths, 21 9ths, 49 10ths, 5 11ths, 27 12ths, 16 13ths, 21 14ths, 49 15ths, &c. *in infinitum*; the five Numbers 5, 27, 16, 21, 49, will continually circulate, or be repeated, conſequently the Series can never terminate; however we are certain at the Beginning of the Series, that the whole Time amounts to but little more than 1 Hour, 5 minutes, 27 ſeconds, and that all the following part of the Series, though carried on ever ſo far, cannot amount to ſo much as half another ſecond of Time.—Dr. *Keil* inſtances in two or three more; but all equally trifling.

Mr. *Rowning* in his Introduction to his Syſtem of Natural Philoſophy, informs us that “*Des Cartes* ſuppoſes that God created a certain Quantity of Motion, and aſſigned it to the whole Maſs of created Matter, and that Motion being once created could no more

‘ be annihilated without an omnipotent Hand,
‘ than Body itſelf: in Conſequence of which,
‘ he was obliged to teach, that the Quantity
‘ of Motion is always the ſame; ſo that if all
‘ the Men and Animals in the World were
‘ moving, yet ſtill there would be no more
‘ Motion than when they are at reſt; the
‘ Motion which they had not when at reſt
‘ being transferred to the Æther. So unac-
‘ countable are the Notions of this great Phi-
‘ loſopher, that it is ſurpriſing his Doctrine
‘ ſhould have met with ſuch univerſal Recep-
‘ tion, and have got ſo ſtrong a Party of Phi-
‘ loſophers on its Side: That notwithſtanding
‘ it was more abſurd than the Schoolmen's
‘ ſubſtantial Forms, they muſt all be exploded
‘ to make way for his ingenious Hypotheſis.”

The ſame Author informs us, that “ ſo
‘ wild and extravagant have been the Notions
‘ of a great part of Philoſophers, both antient
‘ and modern, that it is hard to determine
‘ whether they have been more diſtant in their
‘ Sentiments from the Truth, or from one ano-
‘ ther, or have not exceeded the Fancies of
‘ the moſt fabulous Writers, even Poets and
‘ Mythologiſts.—This was owing to a preci-
‘ pitate Proceeding in the ſearching into Na-
‘ ture; their neglecting the Uſe of Geometry
‘ and Experiments, the moſt neceſſary Helps
‘ to the finding out of Cauſes, and proportion-
‘ ing them to Effects.”——But, Mr. *Rowning*
himſelf is here guilty of a great Miſtake that he

was not aware of, nor indeed could he be: The only Reaſon of ſuch different Sentiments was, that former Philoſophers being ignorant of that univerſal Fire, which we have ſince diſcovered, were neceſſarily wrong in many things: This is what appears to be the true Reaſon of that Variety of different Sentiments among them. Mr. *Rowning* himſelf is ſilent as to the Cauſe of Motion, any farther than informing us what were the Sentiments of *Des Cartes* concerning it, as abovementioned.

According to Dr. *Stephenſon*, Motion is an abſolute Cauſe, and acts as a delegated Agent to bring about or produce natural Effects.

" Among ſecondary Cauſes, Motion," he ſays, " is the principal immediate *Agent* and ' *Inſtrument* of all the Effects, Operations, and ' Phenomena that are produced in the material ' Univerſe, and is the primary *Cauſe* upon which ' the Power, Force, and Energy of every Body, ' or Syſtem of Bodies, wholly depends. For ' Matter, or Bodies without Motion, can neither ſuffer any Change in themſelves, nor ' produce any Change or Alteration in other ' Bodies, but would remain for ever in a ſtate ' of abſolute Reſt and Inactivity; ſo that whatever Changes or Mutations happen in Bodies, ' the ſame are all neceſſarily produced by ' Motion, either added thereto, or ſubtracted ' therefrom. For which Reaſon we find, that ' according to the preſent eſtabliſhed Order of ' Nature, Matter and Motion are rendered

‘ inſeparable; the whole Syſtem of Matter, and ‘ all material Beings, both animate and inanimate, being for ever ſubject to ſome degree ‘ of Motion, more or leſs, by which they are ‘ kept in a continual Circulation or Fluxion, ‘ and thereby fitted to undergo and paſs thro’ ‘ different States, Forms, Periods, and Appearances, according to the final Ends and Appointments of Providence. And thus we ‘ obſerve, that all animal and vegetable Bodies, ‘ from the higheſt to the loweſt Degree in the ‘ Scale of Life, as well as all other material ‘ Beings, even the great Planetary and Cometary Bodies themſelves, which compoſe this ‘ ſolar Syſtem, are conſtituted and formed to ‘ continue only for a certain Revolution and ‘ Period, ſome longer, ſome ſhorter; which is ‘ no other than a progreſſive Motion, whereby ‘ they paſs through different Scenes and States, ‘ and put on different Forms and Appearances; ‘ which when accompliſhed, they become ‘ reſolved again into the general elementary ‘ Maſs of Matter, tho’ even then they are neither diveſted of Exiſtence nor Motion, but are ‘ ſtill in a Progreſſion to new Life, Form, and ‘ Being” (*a*) —See Dr. *Stephenſon*’s Introduction to his Mechanical Phyſician, p. 11, or p. 242 of my Philoſophical Eſſays.

Eſſays, Part 2d, ſect. 146.—“If we do but ‘ caſt an Eye of Contemplation on the general

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(*a*) Here note, that the Doctor treats on Motion as a Cauſe.

‘ Phenomena of Nature, we perceive Motion in almoſt every Part. — That the Matter contained in the viſible Creation is full of Motion, is ſo obvious as not to be denied; though the mechanical Cauſe of it, and how ſupported and preſerved, has been much controverted. But ſo long as we were ignorant of the *Exiſtence* of Fire as a durable Principle, ſo long were we neceſſarily ignorant of the Cauſe of ſuch *Motion*. Before ſuch a ſubtile Medium or Æther was diſcovered, the Cauſe of *Motion* was given up, along with other immechanical Cauſes, to be performed by the immediate Influence of the Firſt Cauſe.”

“ Before ſuch a Diſcovery was made, we ſeemed naturally enough to conclude that all Matter was inert; whereas we now find we were greatly miſtaken, and that there are active Particles of Matter exiſting, as well as paſſive, the Effects of which active particles, particularly thoſe contained in the Pores of groſs Bodies, were ſuch, that the groſs Particles *themſelves* appeared (in many different Circumſtances) to be endued with *active Properties*. But had we attended to Sir *Iſaac*'s Principia, we might have learned better: There he informs us, That the Cauſe of that Activity is not in the groſs Particles themſelves, as we imagined, but in the ſubtile elaſtic Medium exiſting in their Pores” (*a*)

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(*a*) See the laſt Paragraph of his Principia.

"'This was a much more natural Deſcription 'of it than could at that Time have been rea'ſonably expected, particularly, as Sir *Iſaac* 'confeſſed he was at a Loſs for proper Expe'riments to inveſtigate the Laws by which it 'operated."

"Nature almoſt every where appears replete 'with phyſical Cauſes to produce all kinds of 'neceſſary Motions, not only among Animals, 'Vegetables, *&c.* but even in the celeſtial 'Regions.—For all Motions in the Microcoſm, 'both voluntary and natural, the moſt ample 'Proviſion is made: And can we imagine a 'leſs Proviſion for Motion in the Macrocoſm, 'particularly now we have made a compleat 'Diſcovery of ſuch an active and extenſive 'Agent, exiſting in Nature, as was never 'credited before?"

"A principal Cauſe of Motion among in'animate things is the deſtroying and reſtoring 'the Equilibrium; the Effects of almoſt all 'thoſe remarkable Experiments in Electricity, 'appear to be founded on Nature's Efforts to 'reſtore the deſtroyed Equilibrium, by means 'of the exquiſite Elaſticity and Rarity of the 'ſubtile Fluid, alternately exerting their diffe'rent and contrary Forces, acting with, or 'counteracting the Spring and Preſſure of the 'Atmoſphere. Heat and Cold are likewiſe 'productive of like Effects; which two oppo'ſite Qualities are wonderful, and were in ſuch 'remarkable Eſteem with the great Lord *Ba-*

‘ *con*, that he compared them to the two Hands ‘ of Nature. How much more then had he ‘ lived to ſee the ſurpriſing Effects of Oppo‘ ſites, which are brought about by thoſe two ‘ inherent Properties of this grand Principle ‘ of Nature, namely, exquiſite Rarity and ‘ Elaſticity in the Medium juſt diſcovered.”

“ Thoſe who had rejected ſuch a Medium, ‘ and conſequently ſuch a manner of reaſoning, ‘ were much diſtreſſed for the Cauſe of Motion, ‘ having thereby ſhackled themſelves with in‘ ſuperable Difficulties and Inconſiſtencies.”

DIALOGUE XII.

On the CAUSE *of* GRAVITY.

B. WHAT is Gravity? For I muſt confeſs I have but a very confuſed Idea of it, it being uſed in ſo many different ſenſes, as if the Word was deſigned to be guarded from having any particular meaning at all. The word *Attraction* is frequently uſed inſtead of it; which is ſometimes made Uſe of as a Cauſe, ſometimes as an Effect: Sometimes we have the Expreſſions, *Attraction* or *Gravity*, juſt as if thoſe two words had but one and the ſame meaning, and might be uſed promiſcuouſly; with many other Inconſiſtencies; as Attraction *and Gravity*; Attraction *or Gravity*; Attraction *of Gravity*; Attraction *of Coheſion*; Attraction *of Magnetiſm*; Attraction *of Electricity*; *&c. &c.* In ſhort, I can, as I ſaid, find no meaning affixed to either of the two words *Gravity* or *Attraction.*

A. What you ſay is true, and was all owing to the perplexed State of Things, and the Obſcurity in which Philoſophy was then involved. The Caſe was the ſame with the preſent Electrical Philoſophers; nor could they extricate themſelves before the modern Experiments cleared away the Darkneſs. To ſay the Truth, before that Time it was morally impoſſible to behold Things as they really were: The Inconſiſtencies and Diſingenuity of men in making Uſe of two ſuch different Words in one and the ſame Senſe is too apparent to be denied.

B. What are the Sentiments of Electrical Philoſophers as to this intricate Subject, *Gravity*; for it would be a great Satisfaction to me to hear a rational Account of it?

A. I will readily give you the moſt rational I can, and what appears ſo to them. Gravitation, or a centripetal Tendency of Bodies, is two-fold; firſt, a tendency towards the Centre of the ſolar Syſtem; and, ſecondly, a tendency towards the Centre of the Earth: The moſt obvious of which is the latter, and is evidently pointed out by all Falling Bodies; and the former is treated of and explained, in the Theory of the Sun, p. 231 of the Eſſays.

B. How do they account for the Cauſe of that centripetal Tendency ſo obvious in all Bodies: I mean, that Tendency of all common Matter towards the Centre of the *Earth?*

A. From an exterior Preſſure of the univerſal, elaſtic, æthereal Fluid, which plainly appears when we conſider the Phenomena exhibited by Falling Bodies; I mean, thoſe remarkable Accelerations, which not only plainly point out the great Violence of the Force or *Cauſe*, but are alſo plain Indications that the Cauſe of the Gravity of Bodies towards the Centre of the Earth is an exterior and impelling Force, and not an inherent and eſſential Property of Matter, as hath been heretofore maintained by many others. The Electrical Philoſophers allow indeed, that to outward Appearance, the Cauſe of Gravity towards the Centre of the Earth, ſeems to be a real and eſſential Property of *Matter*, interwoven, as it were into the very conſtituent Parts of the Matter of which our Bodies are compoſed. But nothing can be a plainer Proof, that the *Cauſe* of the gravitating Tendency of all Bodies towards the Centre of the Earth is an exterior Force, than thoſe Accelerations of the Motion of deſcending Bodies. Beſides, were the Cauſe ſeated within the Bodies themſelves, their Motion when deſcending muſt be more regular and uniform; conſequently the Accelerations are the Effects of an external Force (*a*)

B. As you are now ſpeaking of the *Cauſe* of Gravity, you muſt excuſe me if I claim your Promiſe of recapitulating your Theory of the Nature and Office of the Sun.

A. I ſhall with Pleaſure fulfill my Engagement to you; and am inclined to hope, that if you conſider my Theory with due Attention, (for I will venture to call it mine, having never read or heard of it before) you may at length thank me for the Recapitulation; ſince it will explain to you in the moſt natural and cleareſt Manner hitherto known, the true Cauſe of the centripetal Tendency of all the heavenly Bodies towards *their* Centre.

In the firſt Place, I muſt inform you that the Dimenſions of the Sun are briefly as follow (*b*): Diameter, 796400 Engliſh Miles;—Circumference, 2501970 Engliſh Miles;—— Area of the greateſt Circle or Face of the Sun, 498142274784 Square Miles; — Superficial Content, 1992569099136 Square Miles; — Solid Content, 264479674235618688 Cubical Miles.

" What a ſtupendous Maſs this! Moſt exquiſitely formed and adapted to the Office for which it was ordained, and with no leſs than infinite Wiſdom! And yet, when we take a general

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(*a*) See Page 65, 66, on Falling Bodies.

(*b*) See Philoſophical Eſſays, p. 332.

general Survey of the Works of the Creation, we find nothing made in vain; nothing ſuperfluous or redundant; and notwithſtanding this, all is performed (as Sir *Iſaac Newton* has clearly demonſtrated in his Principia) with mathematical Exactneſs!"

"That ſo large a Body was created for Ends proportionably great, cannot be doubted; and its very Situation is no ſmall Indication of the ſame. What thoſe Ends are, tho' it may be impoſſible ever to find them all out, yet, by proceeding with due Caution, we may very probably be able to obtain ſufficient Data to conduct us to many uſeful Truths; and even when the Analogy appears true, and yet falls ſhort of a Demonſtration, it may then be put down by way of Interrogation or Quere, that the ſame thing may be further enquired into by others."

"The next remarkable Characteriſtic relating to that glorious Object, and which is moſt obvious, are the Rays perpetually darting from him. This Phenomenon ſeems to indicate and point out his Office, *viz.* that of a Circulator. For, as hinted above, as he is every Moment emitting his Beams from all Parts of his Body, it may rationally be concluded, that as conſtant a Supply of the ſame elementary Fire will be thought abſolutely neceſſary in order to preſerve an Equilibrium.

"As in Mathematics there is no proceeding forward without proper Data, ſo it fares in Philoſophy: Unleſs the Problem hath ſufficient

Data, the Mathematician labours in vain, and can never inveſtigate his Theorem; no more can the Philoſopher without proper Requiſites inveſtigate his Theory."

" Arguing from Analogy is an approved Method of inveſtigating the Knowledge of things. Now the Body of Man has been thought by ſome of the moſt curious Obſervers of Nature to be analogous to the Syſtem of the world, and was therefore termed the Microcoſm, or World in Miniature, to diſtinguiſh it from the Macrocoſm, or great World. Let us then conſider the Microcoſm, which we beſt underſtand. This minute World we know to be compoſed of Solids and Fluids, and to be full of Motion; and alſo that the Motion of the ſolid Parts (and conſequently that of the whole Machine) is from the Effects of the Motion of the bodily Fluids; for if their Motion be retarded in any Degree, a proportionable Defect is ſure to follow among the Solids alſo; and whenever their Motion entirely ceaſes, the whole Machine becomes motionleſs, inanimate, and dead."

" The next thing to be conſidered is the phyſical Cauſe of this natural Motion of the bodily Fluids;—which Motion we are well aſſured is performed by the Heart; an Engine or Inſtrument fitly contrived and adapted for that purpoſe, and placed in the moſt commodious part of the minute Syſtem for that End."

" If then, I ſay, the ſureſt Way to arrive at the Truth is to argue from Analogy, *i.e.* from

Things well known, to thoſe leſs known; the Macrocoſm, or great World, is alſo well known to conſiſt of Solids and Fluids, and to be replete with a Variety of Motions; which Motions, from repeated Obſervations, appear to be owing to the Effects of an active æthereal Fluid: This has been often conjectured before, and inſiſted on by ſome of the greateſt and moſt eminent Philoſophers, particularly Sir *Iſaac Newton* and Biſhop *Berkeley*; but as their reaſoning could never be ſufficiently ſupported by proper Experiments before the late Diſcoveries by Electricity, the Evidences they produced were not properly regarded."

" From the ſame Method of reaſoning we are naturally conducted to the Sun as a Circulator in the Macrocoſm, which (as we find by the Effects of thoſe Burning Mirrors) ſends forth ſuch Plenty of a powerful æthereal Fluid, or pure elementary Fire."

" Since then, by this Method of reaſoning, we compare great things with ſmall; may not the Sun, with ſufficient Propriety, be termed the *Cor Mundi*, or the Heart of the World, ſimilar in its Office to the Heart in the Body, diſpenſing the æthereal Fluid to the utmoſt Limits of the Syſtem? Particularly, when we conſider that ſuch a conſtant Emiſſion of that æthereal Fluid from the Sun's Body muſt require as conſtant a Supply. How that is performed I am now to enquire."

"This Fluid, like the Blood in the Body, is from thence returned to maintain the Circulation: For as the Blood in the Microcoſm is by the Force of the Heart protruded to the utmoſt Limits of the minute Syſtem, and when it can proceed no farther, returns back to the Heart again, to keep up and maintain the Circulation: So, if the Analogy holds good, the æthereal Medium in the Macrocoſm, when protruded to the utmoſt Limits of the Syſtem of the World, and can proceed no farther, returns in like Manner back to the Sun to maintain the Circulation: By what means ſuch a Return is effected in the Macrocoſm, I ſhall endeavour to ſhew."

"According to the modern Aſtronomy, every fixed Star is of the ſame Nature and performs the ſame Office that the Sun does in our ſolar Syſtem, which Opinion is ſupported by many rational Arguments, ſome of which are the following."

"Firſt, The Light of the fixed Stars is not a borrowed Light, like that of the Planets; but innate, as that of the Sun."

"Secondly, their Diſtance is ſo immenſely great, as to afford no perceptible annual Parallax; that is, ſo great, that the Diſtance of 162000000 of Miles (equal to the Diameter of the Earth's annual Orbit) nearer or farther from them, makes no ſenſible Difference in their Altitude: Neither does a celeſtial Teleſcope, which magnifies ſeveral hundreds of

Times, make any Difference as to their Magnitude; which are undoubted Indications that their Diſtance is immenſely great: And conſequently,"

"Thirdly, If the Sun were placed at the ſame vaſt Diſtance, it would appear like ſuch another lucid Point."

"Every fixed Star then being allowed to be the Centre of a Syſtem of Planets and Comets, performing the ſame Office as the viſible Sun, and like that perpetually darting its radiant Beams to the utmoſt Boundaries of each reſpective Syſtem, and far beyond; the conſequence muſt be, that the profound Abyſs, or what is by ſome termed the Immenſe Void, is moſt replete with Æther of all other Parts, *i. e.* that Part of Space which we thought the moſt void and empty, contains the greateſt Fullneſs and the denſeſt Æther; *i. e.* the farther from thoſe ſeveral grand Luminaries, the more denſe it is conceived to be."

"To render this yet more plain and intelligible, ſee Plate II. which will convey a more clear Idea than a Multitude of Words: Where S, at the Centre, repreſents the Sun: The ſix concentric Circles, the ſeveral Orbits of the Planets: The ſmall Lines, or ſtrait Strokes, the ſolar Rays. The ſame is to be underſtood of all the ſurrounding ſolar Syſtems."

"Theſe things conſidered, let us hear Sir *Iſaac Newton* himſelf. "Every Body," he ſays, 'endeavours to go from the denſer Part of the

Medium towards the rarer: And if this Medium be rarer within the Sun's Body than at his Surface, and rarer there than at the hundredth part of an Inch from his Body, and rarer there than at the fiftieth of an Inch from his Body, and rarer there than at the Orb of *Saturn:* I ſee no Reaſon why the Increaſe of Denſity ſhould ſtop any where, and not rather be continued thro' all Diſtances from the Sun to *Saturn*, and beyond. And tho' this Increaſe of Denſity may, at great Diſtances, be exceeding ſlow, yet if the elaſtic Force of this Medium be exceeeding great, it may ſuffice to impel Bodies from the denſer Parts of this Medium towards the rarer, with all that Power which we call Gravity. And that the elaſtic Force of this Medium is exceeding great, may be gathered from the Swiftneſs of its Vibrations." Optics, Quære 21.

"Theſe things, tho' delivered as a Quære, muſt be allowed to be his real Sentiments, as is manifeſt from the Advertiſement in the ſecond and later Editions of his Optics, where he acquaints us, that "to ſhew he did not take Gravity for an eſſential Property of Bodies, he had added one Queſtion concerning its *Cauſe*, chooſing to propoſe it by way of a Queſtion, becauſe he was not then ſatisfied about it for Want of Experiments."

"Thus far Sir *Iſaac*'s Opinion ſeems to coincide exactly with the preſent Plan. Since then it appears reaſonable to ſuppoſe, that the farther the ſolar Rays proceed from him, the more denſe they are; conſequently, when they have gone on ſo far as to meet with thoſe Rays from the neareſt ſolar Syſtems around them, they muſt, in thoſe far diſtant Regions, be denſeſt of all. Is it not then natural to conclude, that at ſo denſe a part of an extremely elaſtic Medium, it muſt from thence return again to the moſt rare part from whence it was ſent, and, in its Progreſs, cauſe the centripetal Force of the Planets; *i. e.* that Force which cauſeth them to gravitate towards the Sun? Hence a Circulation in the Macrocoſm appears as agreeable to Reaſon as a Circulation in the Microcoſm; and that Gravity is performed by an impelling Force. — Is it not reaſonable alſo to ſuppoſe, that ſuch a gradual Increaſe of the Denſity of the Æther, from the Sun to the utmoſt Limits of the Syſtem, is the true mechanical Cauſe why *Saturn*, in the denſer Part of the Medium, moves ſlower than *Jupiter*, in a rarer; and again, *Jupiter* than *Mars*; *Mars* than the *Earth*? &c."

"What a compleat, glorious, and ſtupendous Piece of Machinery then is the ſolar Syſtem! How much more ſo is the whole Frame of Nature! And how conſummate the POWER, the WISDOM, and the GOODNESS of the Divine and Incomprehenſible Architect of the Univerſe!"

"Hence there appears a more general Cauſe of Motion in the World than what has been hitherto ſuppoſed; and an adequate Method to render the centripetal Forces of the Planets and Comets intelligible and rational."

The ſolar Syſtem then may not improperly be conſidered as a concave Sphere, where the greateſt Denſity or Spring is conceived to be at the Surface, or Circumference, and preſſing from every individual Part of it towards the Sun or Centre.——If Enquiries are purſued on this Plan, they muſt neceſſarily terminate in an univerſal Plenum of the ſame elementary Fire.

COHESION.

"COHESION, in Phyſicks, is the Action ' whereby the Particles or primary Cor-' puſcles, whereof natural Bodies conſiſt, are ' connected or bound together, ſo as to form ' Particles; and thoſe again kept together, ſo ' as to form ſeveral Maſſes or Bodies."

"The Cauſe of this Coheſion, or *Nexus Ma-' teriæ*, has extremely perplexed the Philoſo-' phers of all Ages. In all Syſtems of Phyſicks, ' Matter is ſuppoſed originally to be in minute ' indiviſible Atoms."

"How and by what Principle theſe ſeveral ' and diſtinct Corpuſcles ſhould come firſt ' joined and combined into little Syſtems; ' and how they ſhould come to perſevere in ' that State of Union; is a Point of the utmoſt ' Difficulty, and even of the moſt Importance, ' of any in Phyſicks?"

“ The moſt popular Opinion is *that* ſo ſtre‘ nuouſly defended by *J. Bernoulli, de Gravitate* ‘ *Ætheris*; who accounts for the *Coheſion* of the ‘ Parts of Matter, from the uniform Preſſure ‘ of the Atmoſphere; confirming this Doctrine ‘ from the known Experiment of two poliſhed ‘ marble Planes, which cohere very ſtrongly ‘ in the open Air, but eaſily drop aſunder in ‘ an exhauſted Receiver.—But tho’ this The‘ ory might ſerve tolerably well to explain the ‘ *Coheſion* of Compoſitions, or greater Collec‘ tions of Matter, yet it falls ſhort of account‘ ing for the firſt *Coheſion* of the Atoms, or ‘ primitive Corpuſcles, whereof the Corpuſcles ‘ of hard Bodies are compoſed.”

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Sir *Iſaac Newton* delivers his Doctrine of *Coheſion* thus: “ The Particles of all hard ho‘ mogeneous Bodies, which touch one another, ‘ *cohere* with a great Force; to account for ‘ which, ſome Philoſophers have Recourſe to a ‘ kind of hooked Atoms, which, in effect, is ‘ nothing elſe but to beg the Thing in queſtion. ‘ Others imagine, that the Particles of Bodies ‘ are connected by Reſt; *i. e.* in effect, by no‘ thing at all: And others, by conſpiring ‘ Motions; *i. e.* by a relative Reſt among them‘ ſelves. For myſelf, it rather appears to me, ‘ that the Particles of Bodies *cohere* by an at‘ tractive Force; whereby they tend mutually ‘ towards each other; which Force, in the ‘ very Point of Contact, is very great; at little ‘ Diſtances is leſs, and at a little farther Diſ-

'tance is quite inſenſible.—Now if compound 'Bodies be ſo hard, as by Experience we find 'ſome of them to be, and yet have a great 'many hidden Pores within them, and conſiſt 'of Parts only laid together; no doubt thoſe 'ſimple Particles which have no Pores within 'them, and which were never divided into 'Parts, muſt be vaſtly harder."

"For ſuch hard Particles gathered into a 'Maſs, cannot poſſibly touch in more than a 'few Points; and therefore much leſs Force 'is required to ſever them, than to break a ſolid 'Particle, whoſe Parts touch throughout all 'their ſurfaces, without any intermediate Pores 'or Interſtices. But how ſuch hard Particles 'only laid together, and touching only in a 'few points, ſhould come to *cohere* ſo firmly, 'as in fact we find they do, is inconceivable, 'unleſs there be ſome Cauſe whereby they are 'attracted and preſſed together."

"Now the ſmalleſt Particles of Matter may '*cohere* by the ſtrongeſt Attractions, and con'ſtitute larger, whoſe attracting Force is fee'bler: And again, many of thoſe larger Par'ticles cohering, may conſtitute others ſtill 'larger, whoſe attractive Force is ſtill weaker; 'and ſo on for ſeveral Succeſſions; till the pro'greſſion end in the biggeſt Particles, on which 'the Operations in Chymiſtry and the Colours 'of natural Bodies do depend; and which by '*cohering* compoſe Bodies of a ſenſible Mag'nitude."

The different Degrees of *Coheſion* conſtitute Bodies of different Forms and Properties.—— Thus the ſame great Author obſerves, " the ' Particles of Fluids, which do not *cohere* too ' ſtrongly, and are ſmall enough to render ' them ſuſceptible of thoſe Agitations which ' keep Liquors in a Fluor, are moſt eaſily ſeparated and rarefied into a Vapour, and make ' what Chymiſts call *volatile Bodies*; rarefying ' with an eaſy Heat, and again condenſing with ' a moderate Cold."

" Thoſe whoſe Particles are groſſer, and ſo ' leſs ſuſceptible of Agitation, or *cohere* by a ' ſtronger Attraction, are not ſeparable without ' a greater Degree of Heat, and ſome of them ' not without Fermentation; and theſe make ' what the Chymiſts call *fixt Bodies*."——See *Chambers* under the Word Coheſion.

Coheſion of the Parts of Matter is obſerved to be ſtronger or weaker according to the different Qualities of the adhering Particles. The Cauſe of which Phenomenon was ſo intricate and perplexing as to be given up by Enquirers, even the moſt ſagacious Naturaliſts, as impoſſible to be accounted for on any natural or rational Principles whatever.——And the Rev. Mr. *Jones*, in his Eſſay on the Firſt Principles of Natural Philoſophy, obſerves, " that there ' are a Sort of Reaſoners amongſt us, who ſeem ' to glory in their Ignorance, and have precipitately defied all the Philoſophers upon ' Earth to account for the *Cauſe* of Coheſion,

‘ otherwiſe than by the Power of the Deity ‘ immediately intereſted.”

This being the Caſe before the Diſcovery of Fire, it may be well worthy our Enquiry, whether ſome Light may not be ſtricken out upon that Subject, ſince a pure permanent Fire has been diſcovered. — It ſeems the more promiſing on account of our having diſcovered by electrical Experiments that this Fire is univerſal, not only in all open Spaces, but exiſts in the Pores of all Bodies.—Of the Truth of this Poſition we are certain; ſince it is undeniably proved by Experiments in general, to be obtained from the Pores of groſs Bodies; and that which leaves us leſs Reaſon to doubt is, that altho’ it be real and pure Fire, yet we obtain it with the greateſt Eaſe and in the greateſt Plenty from nothing (Metals excepted) ſo much as from Water

The Coheſion of Matter, or what we term Solidity, is very different in different Bodies; ſome cohering much ſtronger than others; which Differences prevail even among Bodies belonging to the ſame Claſs, as for Inſtance in Metals.

In the 3d Part of my Eſſays, p. 441, when treating on Coheſion, it is obſerved, that the moſt promiſing Method to obtain a true Idea of the *Cauſe* of Coheſion, is by means of a previous Enquiry into the Manner by which the ſtrongeſt Coheſions may be *deſtroyed*. To effect which, it is neceſſary to premiſe what we find confirmed by a Variety of electrical Experiments, particularly by many that are contained in chap. 3d of the 1ſt Part; *viz.* that of a ſubtile Medium exiſting in the Pores of all groſs Bodies; which Medium, when obtained from their Pores by means of the electrical Apparatus, is found to be real and true Fire; ſo that, as is there obſerved, in the melting of Metals there is no more Fire introduced into them than was before; all that ſeems requiſite to deſtroy the Coheſion is, only to communicate a ſufficient Degree of Heat to the component Parts of that Fire already in their Pores: Accordingly we find, that as ſoon as ſuch a Heat is communicated to it, the Particles of the Fire contained in the Pores become ſo expanded, that the Particles of the Metal become ſeparated from one another; *i. e.* a Fuſion enſues: But no ſooner is the Violence of the Heat a little abated, and by that means the Expanſion of the Particles of the internal Fire leſſened, than the former Coalition of the groſs Particles begins to take place again; and as the Heat more and more decreaſes, that Expanſion being thereby more and more contracted, the Coheſion becomes again more and more compleat. Or it may otherwiſe be thus defined:

The *Pneuma, Eſſence,* or *Spirit* of Lord *Bacon*; that elaſtic preſſing Agent, which we find by experiment to be conſtantly deſcending from the upper Regions to the Earth in general, and to all rarefied Parts in particular, is the real cauſe why

Bodies deſcend with ſuch Force and Celerity, and why the Parts of the Metal coaleſce before and after the Fuſion; which violent and preſſing Force of the Agent is yet overcome by the more violent counteracting Force of the expanded Fire in the Pores of the metal, when ſo intenſely heated; *i. e.* the violent Intumeſcence or Expanſion of the heated Fire in the Pores of Metal, overcomes the elaſtic Preſſure even of that very Pneuma, (which before cauſed the Parts to cohere) and by that means bears it away from the Metal: This ſeems clear, ſince a Fuſion immediately enſues, and continues as long as the ſame Heat continues; but, as before obſerved, when the Heat, and conſquently the Expanſion of the internal Fire, leſſens, the Coheſion again commences, and increaſes in the ſame Proportion.

To illuſtrate this Doctrine. The ſix Metals are found to be endued with ſix different Degrees of Firmneſs, and require as many different Degrees of Heat to melt them; *i. e.* to deſtroy their Coheſion: Of which in their Order.

Firſt. Tin, being of the moſt looſe Texture, let the Degree of Heat which is ſufficient to melt it be called one.—As the Metal cools the Coheſion again commences, and when cold, the Coheſion is then perfect.

Second. Lead, being more compact, requires two Degrees of Heat to deſtroy the Coheſion. As this cools the Coheſion commences as before.

Third. Silver, being the next in Order, requires three Degrees of Heat to deſtroy the Coheſion.

Fourth. Gold, the Adheſion of the conſtituent Parts of which being ſtill more tenacious, requires four Degrees of Heat to deſtroy the Coheſion.

Fifth. Copper requires a ſtill greater Heat to fuſe it.

Sixth. Iron, being the hardeſt of all Metals then known, requires the greateſt Degree of Heat of all others to deſtroy the Coheſion.

Or otherwiſe, by way of Illuſtration, and, if poſſible, to render it ſtill more plain and intelligible.

Quickſilver having of late Years been diſcovered to be capable of being frozen (*a*), and by that means rendered a perfect Metal, we have now ſeven compleat Metals. And if we were for once allowed to call Ice a Metal, the Number would be eight, and nearly in the following Order; *viz.* Frozen Quickſilver, Ice, Tin, Lead, Silver, Gold, Copper, and Iron; and would require eight different Degrees of Heat to deſtroy their Coheſion.

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Firſt. Let the Degree of Heat which deſtroys the Coheſion of the frozen Quickſilver be called one Degree.——It would then be eaſy to conceive, that to cauſe the Particles to cohere again,

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(*a*) Frozen by means of an artificial Cold.——This Diſcovery was made at Peterſburgh. For the Manner of the Diſcovery and Proceſs, ſee my Eſſays, p. 249, 250, et ſeq.

no more would be required than to take away that ſmall Degree of Heat.

Second. Ice, which requires a greater Heat to deſtroy the Coheſion, may be called two Degrees. If then one of theſe Degrees be taken away, the Coheſion is reſtored again

Third. Tin requires three Degrees of Heat to deſtroy the Coheſion; if one of which be taken away, the Coheſion would again commence.

Fourth. Lead requires four Degrees of Heat to deſtroy the Coheſion; one of which being taken away, the Coheſion takes place as before.

Fifth. Silver requires five Degrees of Heat to deſtroy the Coheſion; one of which being taken away, the Coheſion is reſtored.

Sixth. Gold requires ſix Degrees of Heat to deſtroy the Coheſion; which immediately returns on the Removal of one Degree thereof.

Seventh. Copper requires ſeven Degrees to deſtroy the Coheſion; which is reſtored on the withdrawing one Degree of the Heat.

Eighth. Iron requires eight Degrees of Heat to deſtroy the Coheſion; but if one be taken from it, or it be leſſened, the Coheſion in the ſame Proportion returns.

Thus Heat is continually diſſolving ſome Bodies, which a little before in a ſmaller Degree of Heat appeared of a ſolid Conſiſtence.

Hence we have obtained the *Cauſe* of Coheſion, and the Manner how it may be deſtroyed, in a Variety of caſes; which may be ſufficient to illuſtrate and point out the *Cauſe* of other

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Coheſions; particularly ſince we are certain that a ſufficient Degree of Heat will deſtroy the ſtrongeſt; as will be found by conſulting the indefatigable *Boerhaave*'s Account of *Villette*'s Mirror.

"That concave Speculum, or ſolar Burner, ' in a Minute's Time, melted all the ſix Me- ' tals, alſo all the Semi-metals that have been ' hitherto tried: Even ſtony and rocky Bodies ' are melted and vitrified by it in an Inſtant; ' as are Bricks, Clay, Sand, Crucibles, Mar- ' ble, Jaſper, and Porphyry, which are turned ' into Glaſs by it. And laſtly, the very Stones ' which the Maſons make uſe of for building ' the Furnaces deſigned for the fuſing of Iron, ' and ſeparating it from its vaſt, hard, foſſil ' Ore, melt and vitrify in this Focus immedi- ' ately; which no Perſon (let him underſtand ' theſe Things ever ſo well, or let him have ' ſeen ever ſo much of the Violence of confined ' Fires) could ever have imagined: for theſe ' ſame Stones would have remained many ' Years without Alteration in the intenſe Fire ' to which theſe Furnaces are always expoſed: ' So that the Power of this focal Fire is able ' to effect that in the leaſt Inſtant of Time, ' which the other, though the ſtrongeſt we ' know of beſides, could hardly accompliſh in ' the Space of ſome Years." See *Boerhaave*'s Chymiſtry, Vol. I, p. 140, *Dallowe*'s Tranſlation; or my Philoſophical Eſſays, Part II, p. 220, ſect. 102.

Having treated of the above ſeveral Metals, and the different Degrees of Heat required to deſtroy their Coheſion; and ſince the Diſcovery of a Method for the freezing of Quickſilver, the Number of perfect Metals, which before were ſix, was thereby augmented and became ſeven; I ſhall now beg leave to offer to your conſideration a few Hints on the very extraordinary and ſingular Properties of a new Metal, called *Platina* or White Gold (*a*); their Number is therefore now become nine: Of which nine Metals, one of the two laſt added to their Number is the moſt eaſily fuſible, and the other the moſt hard and difficult of all others. The very imperfect Knowledge of the Properties of this extraordinary Metal till within theſe few Years, appears to be owing to the great Difficulty which is found of deſtroying the Coheſion ſo as to bring it to a Fuſion: This was attempted by different Methods, and has been found to withſtand the Force of the moſt in-

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(*a*) Platina is in ſmall and pretty ſmooth Grains, moſt of them reſembling, as to their Figure, pyramidal Triangles with blunted Points; their Colour not much unlike the coarſe Filings of unruſted Iron, but approaching nearer to a ſilvery Whiteneſs, after being ſoaked in an acid, or heated to a high Degree. Mr. *Macquer* ſuppoſes, with great Probability, that the Metal owes its Name to this laſt Property, as derived from the Word *Plata*, which in Spaniſh ſignifies Silver.

The Name of *White Gold*, which has likewiſe been given to this Metal, ariſes out of certain Properties which alſo belong to Gold: Such as to be nearly of the ſame ſpecific Gravity as Gold; to reſiſt like that the Action of Sulphur, Lead, Antimony, the Royal Cement, and all pure Acids: and to ſubmit, like Gold, to no Solvent but *Aqua Regia* and *Hepar Sulphuris*.

tenſe and continued Fires of the Chymiſts without much Alteration: No Heat was yet diſcovered ſufficient for the purpoſe, till one more active than the reſt was thought of, which when properly applied was found to effect a compleat Fuſion. The Agent I mean is that of the *Solar Fire* collected in the Focus of a Burning-glaſs; by which means it was fuſed, and thereby rendered a perfect Metal: No Metal being truly perfect till it is ſo malleable as to ſpread under the Hammer. This was diſcovered by that ingenious Chemiſt Mr. *Macquer*, of the French Academy, and may be found in his Chymical Dictionary under the Word *Platina:* So that with the Addition of this Metal, together with that of Water, we have nine Bodies in Form of Metals, which will require nine different Degrees of Heat to deſtroy, and as many to cauſe their reſpective Coheſions.

On MAGNETISM.

HAVING in the briefeſt Manner treated, firſt, On the Cauſe of Motion; ſecondly, Of Gravity; and thirdly, Of Coheſion: I ſhall next endeavour, in the ſame brief Manner, to ſhew the *Cauſe* of *Magnetiſm*. But the Phenomena exhibited in Magnetiſm are more untractable and difficult than either of the former; and the Cauſe, or rather the Manner or Mode of its acting, ſeems farther out of our Reach.

There can be, however, little doubt, but that the Phenomena are Effects produced from the ſame Cauſe, in a different Mode or Dreſs; In that Form it appears more ſubtile and active than in any other. This was the Reaſon of my calling it Spirit of Æther, and uſing Lord *Bacon's* Appellation, *Pneuma*.

My firſt Hint concerning the Cauſe of Magnetiſm, was from the Phenomena afforded by vertical Bars of Iron, which, by means of that Poſition, were obſerved to acquire a magnetical Virtue. That Phenomenon ſeemed firſt to be taken notice of by Mr *Boyle*. See his Philoſophy, abridged by Mr. *Shaw*, Vol. I p. 498.

A Recapitulation of the Experiment may be ſeen in a Note of my Eſſays, p. 78, ſect. 158, and p. 407; where that Author, after ſpeaking of the Magnetiſm acquired by the Iron Bars of Windows, or any other that have ſtood a conſiderable Time in a vertical Poſition, ſays, "I 'have found, indeed, that if a Bar of Iron, 'which has not ſtood long in an erect Poſture, 'be but held perpendicular, the ſame Experi'ments will ſucceed; but then this Virtue, 'diſplayed by the Extremes of the Iron, will 'be ſo tranſient, that if the Bar be but in'verted, and held again upright, that End 'which juſt before was uppermoſt, and drew 'the North Point of the Needle, will now, 'being lowermoſt, drive it away; which will 'not happen to a Bar that has been for ſome 'Years kept in that Poſition."

From various Obſervations, nothing can appear much more obvious and plain than that Magnetiſm is acquired by means of a moſt ſubtile active Fluid, which pervades the Pores of thoſe Iron Vehicles, and which are capable not only of acquiring by that means a Magnetiſm themſelves, but likewiſe of communicating a ſtill greater Magnetiſm to other Iron Bars; which will more plainly appear a little farther on, when I come to treat of the Manner of the Conſtruction of Artificial Magnets.

According to former Obſervations, Motion, Gravitation, Coheſion, *&c.* are all of them different Phenomena produced by the ſame identical Cauſe; and no reaſonable doubt can be made but that the Cauſe of Magnetiſm is the ſame univerſal, ſubtile, elaſtic Æther, acting in a ſtill different Form. That the Magnetic Virtue, the Electrical Virtue, the Fire of Lightning, are all of them one and the ſame Principle under different Forms, cannot be reaſonably doubted, ſince the Effects from each are the ſame: Magnetic Polarity, for Inſtance, is evidently generated in Iron Bars by means of the ſubtile elaſtic Fluid conſtantly paſſing through them.

Dr. *Franklin* has preſented us with a Method to give ſuch a Polarity to common Needles, as to cauſe them to traverſe when laid on Water; and informs us, that it was a frequent Experiment at Philadelphia, to give a Polarity to Needles by only paſſing the electrical Flaſh through them ——So that the ſame Effects are produced by a Flaſh of electrical Fire as from a Flaſh of Lightning.—— By Flaſhes of Lightning Capt. *Waddel*'s Compaſſes either loſt the Virtue of the Loadſtone, or elſe the Poles were reverſed, the North Point turning towards the South.——We are now, however, demonſtrably certain, that we were egregiouſly miſtaken when we imagined every Magnet to be endued with Poles, an Axis, and an Equator, in a ſimilar Manner with the Earth itſelf. I ſhall therefore deſiſt from any farther Enquiry into the Nature of it, leaving it to the Explanation of Time and Experience; and ſhall conclude this Account of Natural Magnets, with what is, if poſſible, yet more abſtruſe and unintelligible, *viz.* the Manner of conſtructing Artificial ones.

ARTIFICIAL MAGNETS.

"THERE have been ſeveral Methods propoſed for making Artificial Mag-
' nets; but none has yet met with greater Suc-
' ceſs than that of Mr. *Canton*, a Gentleman
' well known to the learned World, and to
' whom we owe the Diſcovery."

The Proceſs.—" Procure a Dozen of Bars,
' ſix of ſoft Steel, each to be three Inches
' long, one quarter of an Inch broad, and one
' twentieth of an Inch thick; with two pieces
' of Iron, each half the Length of one of the

‘ Bars, but of the ſame breadth and thickneſs; ‘ alſo ſix pieces of hard Steel, each five Inches ‘ and an half long, half an Inch broad, and ‘ three twentieths of an Inch thick; with two ‘ pieces of Iron of half the Length, but the ‘ whole breadth and thickneſs of one of the ‘ hard Bars; and let all the Bars be marked ‘ with a Line quite round them at one end. ‘ Then take an iron Poker and Tongs, or two ‘ Bars of Iron, the larger they are and the ‘ longer they have been uſed, the better; and ‘ fixing the Poker upright between the knees, ‘ hold to it, near the top, one of the ſoft Bars ‘ (having its marked end downwards) by a ‘ piece of ſewing Silk, which muſt be pulled ‘ tight by the left hand, that the Bar may not ‘ ſlide; then graſping the Tongs with the ‘ right hand, a little below the middle, and ‘ holding them nearly in a vertical Poſition, ‘ let the Bar be ſtroked by the lower end from ‘ the Bottom to the Top, about ten Times on ‘ each ſide, which will give it a magnetic ‘ Power ſufficient to lift a ſmall Key at the ‘ marked end (*a*); which end, if the Bar was ‘ ſuſpended on a Point, would turn toward the ‘ north, and is therefore called the North Pole, ‘ and the unmarked end is for the ſame Reaſon ‘ called the South Pole. Four of the ſoft Bars ‘ being impregnated after this manner, lay the

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(*a*) Here the Tongs and Poker may be put by as uſeleſs, there being no farther Occaſion for them in the Proceſs.

'two parallel to each other, at the Diſtance of 'one fourth of an Inch, between the two 'pieces of Iron belonging to them, a north 'and a ſouth Pole againſt each piece of Iron; 'then take two of the four Bars already made 'magnetical, and place them together, ſo as 'to make a double Bar in thickneſs, the north 'Pole of one even with the ſouth Pole of the 'other; and the remaining two being put to 'theſe, one on each ſide, ſo as to have two 'north and two ſouth Poles together: Separate 'the north from the ſouth Poles at one end, 'by a large Pin, and place them perpendicularly 'with that end downwards on the middle 'of one of the parallel Bars, the two north 'Poles towards its ſouth, and the two ſouth 'Poles towards its north end: Slide them 'backward and forward, three or four times 'the whole length of the Bar, and removing 'them from the middle of this, place them on 'the middle of the other Bar, as before directed, 'and go over that in the ſame manner; 'then turn both the Bars the other ſide upwards, 'and repeat the former Operation; this 'being done, take the two from between the 'pieces of Iron, and placing the two outermoſt 'of the touching Bars in their room, let 'the other two be the outermoſt of the four 'to touch theſe with; and this Proceſs being 'repeated till each pair of Bars have been touched 'three or four times over, which will give 'them a conſiderable magnetic Power; put 'the half dozen together after the manner of 'the four, and touch with them two pair of 'the hard Bars placed between their Irons, at 'the Diſtance of about half an Inch from each 'other; then lay the ſoft Bars aſide, and with 'the four hard ones let the other two be im-'pregnated, holding the touching Bars apart 'at the lower end near two tenths of an Inch, 'to which diſtance let them be ſeperated after 'they are ſet on the parallel Bar and brought 'together again before they are taken off: 'This being obſerved proceed according to the 'Method deſcribed above, till each pair have 'been touched two or three times over; but 'as this vertical way of touching a Bar will 'not give it quite ſo much of the magnetical 'Virtue as it will receive, let each pair be now 'touched once or twice over in their parallel 'Poſition between the Irons, with two of the 'Bars held horizontally or nearly ſo, by draw-'ing at the ſame time the north of one from 'the middle over the ſouth end, and the ſouth 'of the other from the middle over the north 'end of a parallel Bar; then bringing them to 'the middle again without touching the pa-'rallel Bar, give three or four of theſe hori-'zontal Strokes to each ſide. The horizontal 'touch after the vertical will make the Bars 'as ſtrong as they poſſibly can be made, as 'appears by their not receiving any additional

Strength when the vertical touch is given by a great Number of Bars, and the horizontal by thoſe of a ſuperior magnetic Power. This whole Proceſs may be gone through in about half an Hour; and each of the large Bars, if well hardened, may be made to lift twenty eight Troy Ounces, and ſometimes more. And when theſe Bars are thus impregnated, they will give to an hard Bar of the ſame Size its full virtue in leſs than two Minutes; and therefore will anſwer all the Purpoſes of Magnetiſm in Navigation and experimental Philoſophy much better than the Loadſtone, which is known not to have a ſufficient Power to impregnate hard Bars. The half dozen being put into a Caſe, in ſuch a manner as that two Poles of the ſame Denomination may not be together, and their Irons with them as one Bar, they will retain the Virtue they have received; but if their Power ſhould, by making Experiments, be ever ſo impaired, it may be reſtored without any foreign Aſſiſtance in a few Minutes. And if, out of Curioſity, a much larger ſet of Bars ſhould be required, theſe will communicate to them a ſufficient Power to proceed with, and they may in a ſhort Time, by the ſame Method, be brought to their full Strength.”

A. HAVING thus far extended my Enquiries into the Nature, Properties, and Uſes of Fire, in order to evince it to be an *univerſal* Agent in the ſtricteſt Senſe of the Word, and the true phyſical Cauſe of the ſeveral Phenomena of Nature before recited, which have been long ſince given up as inexplicable by any philoſophical Principles hitherto known, I muſt inform you of one Thing more relating to Electricity, which I cannot omit, it being of a moſt ſingular Nature, and manifeſtly tending to confirm the Doctrine of the Univerſality of this electrical Fire. But here I imagine that you will be greatly ſurpriſed, as I was myſelf, at ſuch unexpected Effects from a moſt ſimple Apparatus; an Apparatus conſiſting of nothing more than a Pair of Stockings.

These Experiments have been preſented to the World in ſeveral Papers read before the Royal Society by *Robert Symmer*, Eſq; F. R. S. And, as they illuſtrate my preſent Subject, are curious and entertaining, and, I believe, but in very few Hands; a particular Account of them, I preſume, will not be unacceptable to you.

B. This is indeed ſuch an unheard of Novelty as will worthily engage the Attention of the curious.

A. You will have juſt Reaſon to think ſo, if you will have patience to hear the ingenious Author's own Narration of his Experiments.

B. I ſhould poſſeſs but a very ſmall Share of Curioſity were it not excited by ſuch an extraordinary Account as the Electricity of Stockings.

The following is a Tranſcript of thoſe Papers.

PAPER I.

Read *February* 1ſt. 1759.

"I Had for ſome Time obſerved, that upon pulling off my Stockings at Night, they made a crackling or ſnapping Noiſe; and in the Dark I could perceive them to emit Sparks of Fire: I made no doubt but that this proceeded from a Principle of Electricity; and I was confirmed in this Opinion, by obſerving, that, in Weather favourable for electrical Experiments, thoſe Appearances were more remarkable than at other Times. I mentioned this Obſervation to ſeveral of my Friends, and ſome of them told me, they likewiſe had often perceived the Snapping and Emiſſion of Fire from their Stockings upon pulling them off, eſpecially in the Winter Nights: But I could not hear of any Body that had taken this Phenomenon into Conſideration in a philoſophical Way. For my own part, I could not but think, that ſo ſtriking an Appearance, one that ſeems to have an immediate Connexion with the human Body, or is at leaſt as much about us as the Cloaths we wear, and is obvious to the Perception of our Senſes, merited not only a philoſophical Attention, but the ſtricteſt Enquiry poſſible.

I was the more induced to ſuch an Enquiry, as it ſeemed to me to open a new Path for proceeding in electrical Reſearches, and might perhaps throw new Light on the great and ſurpriſing Diſcoveries already made in that Branch of natural Philoſophy. The Simplicity of the Apparatus, and great Facility in making the proper Experiments, putting it in my Power to begin and carry on my Enquiry at Pleaſure, I entered upon ſomewhat of a regular Courſe of Obſervations about the Beginning of November laſt; and ſince that Time have purſued it as cloſely as my Leiſure and the Weather, which has been far from favourable for electrical Experiments, would permit. It is the Purpoſe of this, and of thoſe Papers that may follow, to lay before the Royal Society an Account of the Experiments and Obſervations I have already made, or may hereafter be able to make, in the Progreſs of this Enquiry.

My firſt Endeavour was to diſcover what Sort of Stockings was moſt proper to produce Electricity, in order to determine this, I tried ſingle Stockings of different Kinds, viz. Thread, Cotton, Silk, and Worſted, putting them on, and wearing them ſome Time. On pulling them off, I could perceive nothing of Electricity in the Thread or Cotton, and no remarkable Degree of it in the Silk and Worſted.

When I ſay, *no remarkable Degree of it*, it may be proper to be a little more explicit. I muſt therefore obſerve, that Silk and Worſted, being in themſelves electric, are both of them, eſpecially Silk, extremely ſuſceptible of Electricity. I have ſometimes obſerved, particularly when the Weather was favourable, that Silk when but barely handled, nay, when but ſimply touched, has become electrical where it had been handled or touched, as appeared by its attracting little light Balls ſuſpended by Threads. It cannot therefore be ſuppoſed that Silk or Worſted Stockings can be put upon the Leg, without being excited to a ſenſible Degree of Electricity. And thence it is, that when taken off they are ſometimes perceived to ſnap though worn ſingle. But whatever Electricity the ſingle Stockings acquires by Friction or otherwiſe, it immediately loſes it upon being ſeperated from the Leg: If any electric Virtue remains, it is no more than what belongs to it as an

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electric Subſtance ceaſing to be excited; and it is in ſo ſmall a Degree, as in the preſent Caſe not to merit Attention. In general, when I ſpeak of the Electricity in queſtion, I mean ſuch a Power of Electricity as is obvious, and perceptible to the Senſes, ſo that the Stockings, after being taken off, ſhould appear more or leſs inflated; throw out an electrical Wind to be felt by the bare Leg; attract or repel another Stocking viſibly; and, upon the Touch, ſnap and emit or receive electrical Fire.

After making the Experiment above-mentioned with ſingle Stockings, I proceeded to try the Effect of two Stockings upon one Leg. This I did with two of Thread, Cotton, Worſted, and Silk ſucceſſively; but this produced no electrical Appearance more than before. I then combined them one with another, and, running through all the different Changes, I found that none of thoſe I then made Uſe of exhibited viſible Proofs of Electricity, but the Silk and Worſted together; and there, indeed, the electric Power appeared remarkably ſtrong. It ſeemed to be a Matter of Indifference whether the Silk or the Worſted were uppermoſt, the Combination of the two was what I judged to be eſſential; and happening at that Time to wear Silk Stockings with thin Worſted under them, I kept to the Uſe of theſe, and found it a convenient

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convenient Circumſtance in the Courſe of my Experiments.

As ſome may have the Curioſity to examine the Obſervations I preſent them with, by Experiments of their own making; before I proceed further, I ſhall furniſh them with a few Remarks, which may enable them to make their Experiments with more eaſe and certainty than if they ſet out unacquainted with ſome Circumſtances, which I have learnt from Experience.

One of the firſt Things to be attended to is the weather, which has an Influence on all electric Experiments, but upon none more than thoſe which relate to this Branch of Electricity. The moſt favourable Weather is that which is dry and clear, and if a little Froſty, ſo much the better. In general, when the Quickſilver in the Barometer riſes, and the Fire burns remarkably briſk and clear, we may expect a conſiderable Appearance of Electricity; at other Times, it is better not to attempt the Experiment.

When the Weather is favourable, it is not neceſſary to wear the Stockings all Day: That, indeed, raiſes the electrical Power to the higheſt Degree; yet, provided they be dry and made warm by the Fire, before they are put upon the Leg, their Continuance upon it for a ſhort Time prepares them ſufficiently for exhibiting viſible Proofs of Electricity. If this ſhould not anſwer upon the firſt Trial, the Operation may be repeated two or three Times to bring them into a proper Diſpoſition to receive the electrical Virtue; and this is no more than what is found to be ſometimes neceſſary with Reſpect to glaſs Globes and Tubes, eſpecially when new. If the Stockings have once acquired this Diſpoſition, they retain it for the Day, or until a Change of Weather, and the Experiment may be repeated with Succeſs as often as one pleaſes; for no ſooner are they diſcharged of their Electricity, than they are ready to receive it anew; nay, if ſpeedily returned upon the Leg, they catch it inſtantaneouſly, and may be immediately pulled off to exhibit a new Exploſion: What is ſtill more ſurpriſing, they ſeem to gather Force by the Frequency of the Repetition, and, to ſome certain Degree, increaſe in electrical Power, provided they be all along kept warm and dry, and that the Leg continue warm.

Another Circumſtance to be carefully attended to is the Manner in which they are to be taken off; for as to the putting them on, it is a Matter of Indifference how that is performed. In taking them off, care muſt be had not to ſeperate them; for if that happens in pulling them off, all the Electricity eſcapes. The beſt way is to put the Hand between the Leg and the Stockings and puſh them off together. Nothing more remains to be done than to pull them aſunder; for upon that, they both of them exhibit a Degree of Electricity, which, when at the higheſt, is really ſurpriſing.

Before I conclude theſe occaſional Remarks, it may not be improper to obſerve, that it is not abſolutely neceſſary that the Stockings be applied to the bare Leg; if a fine Thread Stocking ſeparate them from the Leg, though left upon it when they are taken off, it does not much impair their Electricity. But it is more convenient to uſe the Hand inſtead of the Leg. The Inſertion of the Hand into the Stockings is alone ſufficient, eſpecially in favourable Weather to communicate ſuch an electric Power as renders them capable of anſwering Expectation in ſuch Experiments as I have Occaſion to make (*a*).——I now return to my Subject.

The Opinion I had conceived, that the Combination of Silk and Worſted was neceſſary for the Production of Electricity, ſeemed to meet with Confirmation from all the Experiments I made with the Stockings I then wore. I was at that Time in mourning, ſo that my Silk Stockings were black, and under them I conſtantly wore thin white Worſted. About

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(*a*) An Improvement may perhaps be made upon this, by getting a Piece of Silk or Worſted, knit, or wove in a Stocking Loom, ſo that without being cut it may be formed into the Shape of long Mittens or Sleeves, or rather what we call a Silk or Worſted Tube, &c.

the latter End of November I went out of mourning, and of Courſe changed the Colour of my Stockings. On the ſecond of December, having put on a Pair of white Silk above the Worſted, after I had wore them ſome Hours, I reſolved to amuſe myſelf with a few Experiments. The Weather was remarkably favourable, and I had Reaſon to expect a fine Appearance of Electricity; but upon taking off my Stockings, and pulling them aſunder, to my great Aſtoniſhment, I found they diſcovered no Signs of electrical Power: As I held them in my Hands they hung down collapſed, and did not more attract one another than before they were put upon my Leg. I repeated the Experiment two or three Times, but with no better Succeſs. An Event I ſo little expected diſconcerted me much. I ſaw I was no longer to aſcribe Electricity to the Combination of Silk and Worſted; but I remained at a Loſs to know to what I *ſhould* aſcribe it. At laſt, upon conſidering the Circumſtance of this and other Experiments, a Conjecture occurred, that the Electricity in Queſtion might depend upon the Nature of different Colours. In order to determine this, I thought it faireſt to make the Trial in the ſame Subſtances. Accordingly I had Recourſe to the following Experiment.

I took a Pair of white Silk Stockings, and having warmed them at the Fire put them both upon the ſame Leg. After I had worn them about ten Minutes, I took them off, and pulled them aſunder, but diſcovered no Signs of Electricity in either. I did the ſame with a Pair of black Silk, but to no other Effect. I then proceeded to the deciſive Trial. I put a black and a white Stocking upon my Leg, and wore them likewiſe ten Minutes. I waited with ſome Impatience to ſee the Succeſs of my Experiment, and in return had the Satisfaction of obſerving, upon their being pulled aſunder, that each of them had acquired a ſtronger Degree of Electricity than I had before ſeen: they were inflated ſo much, that each of them ſhewed the entire ſhape of the Leg, and at the Diſtance of a Foot and an half they ruſhed to meet each other. I went through the ſame Experiment with Worſted Stockings, and found that, as in Silk, nothing but the Combination of black and white produced Electricity. As I had often experienced the Power of Electricity in the Combination of black Silk with white Worſted Stockings, there remained to try but that of white Silk with black Worſted, which anſwered as I expected, and ſeemed to complete the Demonſtration.

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A Phenomenon ſo new, and of ſo curious a Nature as theſe Experiments preſented, could not but for ſome Time engage my Attention."

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PAPER II.

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"IN my former Paper, I gave the Society an Account of ſome Experiments made with Silk and Worſted Stockings, by which it appeared, that the remarkable Degree of Electricity they had acquired by being put upon the Leg depended on their being of different Colours, namely, black and white. I did not then, nor do I yet take upon me to determine the Cauſe of this Phenomenon. Whether it be owing to light, which is the Origin of Colours, or only to the Ingredients which enter into the Compoſition of ſeveral Dyes; or to thoſe conjunctly with the Colours they produce; in any of theſe Views the Matter is curious, and equally merits a careful Enquiry. But I fear the Solution of this, and of many other difficult Queſtions concerning Electricity will depend upon the Eſtabliſhment of a more perfect Theory than we have yet attained to. Till we ſhall be ſo fortunate as to diſcover the Nature and Properties of the Powers employed in theſe Operations, we muſt be ſatisfied to purſue the Path of Experiment and Obſervation in queſt of thoſe, as firſt Principles. This is the Method I ſhall

I ſhall continue to follow; and having already ſhewn the Manner of electrifying the black and the white Stocking, it is now my purpoſe to give an Account of the Appearances and Powers of that Electricity ſo excited.

Having made a great Number of Experiments ſince I had the Honour of preſenting my former Paper to the Society, I have had an Opportunity of obſerving, that the Electricity produced between black and white Silk is ſtronger than that between Silk and Worſted of thoſe different Colours, and a great deal ſtronger than that between Worſted and Worſted; the laſt is ſo weak, except in Time of Froſt, or when a ſharp north-eaſt Wind blows, that though the Effects are always of the ſame Nature, yet they are ſometimes ſo languid as to be ſcarce perceptible. I ſhall therefore, and for the ſake of Brevity, confine myſelf in this Paper to what is obſervable with regard to the Electricity between black and white *Silk*.

It is proper to mention another Circumſtance: Having found it troubleſome to electrify the Stockings by putting them as often on my Leg as was requiſite in making Experiments, I have quitted that Method entirely, and ſatisfy myſelf with the Degree of Electricity which is excited in the Stockings by drawing them upon my Hand; and this is to be underſtood with regard to all the Experiments and Obſervations I may have occaſion to mention, unleſs when otherwiſe expreſſed. The Electricity thus produced is not always equally powerful with that which is excited by Means of the Leg; but it is nevertheleſs ſufficiently ſtrong to anſwer all the Purpoſes in View; and it is attended with this Advantage, that the Stockings continue longer fit for theſe Experiments; for like other electrical Apparatus's, they muſt be kept clean and free from all extraneous Matter; and are therefore moſt to be depended upon when new, or when newly waſhed.

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To give a diſtinct Account of the Electricity of black and white Silk, I ſhall trace it through its whole Proceſs, beginning before the Stockings of the different Colours are put together.

After being a little aired at the Fire, when the black Silk is drawn upon the Hand, a crackling Noiſe is heard; and in the dark Sparks of Fire may be perceived as paſſing between the Hand and the Stocking: While it is drawn backwards and forwards the crackling continues, and is moſt conſiderable upon the Separation of the Stocking from the Hand. Thus it appears, that black Silk is highly ſuſceptible of Electricity*; that it is produced almoſt inſtantaneouſly, or at leaſt with very little Friction; that moſt of it eſcapes, while the Stocking is yet upon the Hand; and that upon the total Separation very little remains. This is ſimilar to what happens with the glaſs Tube, when

* Brydone, who wrote by co
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when the Hand, after paſſing along it in one Direction repaſſes it in the other. But ſtill the Electricity that the Stocking retains, after it is ſeparated from the Hand, is conſiderable enough to attract or repel little light Bodies at the Diſtance of one or two Feet: Some Degree of Inflation in the Stocking is likewiſe perceivable; and when a non-electric is brought near it, a Crackling is heard, and in the Dark Sparks may be ſeen. If two black Stockings be drawn upon the ſame Hand at a Time, the Appearances are much the ſame as before; only that the Stockings, when taken off and ſeparated, give ſmaller Proofs of Electricity, than if each of them had been ſingle upon the Hand.

Having found it neceſſary, as I proceed in my Courſe of Experiments, to fix upon ſome Method of aſcertaining the principal Appearances of Electricity, and marking the Degree of it, I had Recourſe to the little Pocket Electrometer of Mr. *Canton*'s Contrivance, which is deſcribed in Vol. XLVIII. No. 93, of the Tranſactions of this Society. When this Instrument is ſupported by Glaſs, it not only ſhews the Attraction and Repulſion, in general, of electrified Bodies, which is one of the moſt eſſential Properties of Electricity, but it diſtinguiſhes between the poſitive and negative State of Electricity, according to reciprocal Attraction or Repulſion of little Balls. By the Terms *poſitive* and *negative*, I mean only to denote the Oppoſition

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Oppoſition of two different States. The particular Allotment of the one or the other Term appears to me to be arbitrary; but that I may not differ unneceſſarily from others, I ſhall apply the word *poſitive* to that ſtate in which a Body is found to be when electrified by the clear glaſs Tube rubbed by the Hand, and the word *negative* when electrified by the rough or opaque glaſs Tube of Mr. *Canton*'s Invention (deſcribed in the Tranſaction mentioned above) when rubbed in the ſame Manner, or by Sulphur or Wax excited. In other Words, when the Body is in a State of Repulſion with the former of thoſe Tubes, we ſay it is *poſitively* electrified, and *negatively* when in a State of Repulſion with the latter, or with Sulphur or Wax.

Nothing appears to be more wonderful than this double ſtate: Here Electricity ſeems to counteract itſelf, the electrified Body attracting in one what it would repel in the other Caſe, and *vice verſâ*. As this remarkable Property may be traced in its Conſequences through almoſt all electrical Appearances, I cannot but think it merits great Attention, and, when it comes to be better underſtood, may throw much light upon the Syſtem of Electricity. However that may be, it was impoſſible for me not to obſerve, that it runs through the whole of that Branch, which I have at preſent under Examination, and to which I return.

White Silk differs much in Electricity from black Silk. When the white Stocking is drawn ſeparately upon the Hand, no crackling is heard nor Sparks of Fire ſeen in the Dark, let it be pulled backwards and forwards ever ſo often: When another white Stocking is drawn on above it nothing more appears; and when ſeparate from the Hand, neither of them diſcovers any Signs of Electricity, excepting, that when brought within a few Inches of the Electrometer, they attract and repel the Balls a little.

If, inſtead of two white or two black Stockings, one white, and over that a black Stocking be drawn upon the Hand, they diſcover not the leaſt Signs of Electricity while they continue upon the Hand, even though they ſhould be drawn backwards and forwards upon it ſeveral Times; nor when taken together from the Hand and preſented to the Electrometer do they appear to have acquired any more than a ſmall Degree of Electricity. They muſt be brought within the Diſtance of a Foot, nay, ſometimes of a few Inches, before they have any Effect upon the Balls; but the Moment they are ſeparated, they are found to be both of them highly electrified, the white *poſitively*, and the black *negatively*. The Circumſtances that appear the moſt to merit Obſervation are as follows:

Firſt, When the Electrometer is placed on a non-electric, and the black Stocking is preſented to it at the Diſtance of three, four, or five Feet, according as it happens to be more or leſs powerfully electrified, the Balls begin to be viſibly attracted, and when it is brought nearer, they are ſeen to be agitated in a violent Manner. If, inſtead of the black, the white Stocking be preſented at the ſame Diſtances, it is found to have preciſely the ſame Effects, attracting and agitating the Balls in the very ſame Manner: From whence it appears, that whatever Difference there was between the Electricity of the black and the white, under other Circumſtances, they each of them acquire an equal Degree of Electricity, by being electrified together.

Secondly, When the Electrometer is ſupported by Glaſs, and the white Stocking is preſented to it, it firſt attracts the Balls, and afterwards repels them; when taken away, it leaves them in a repulſive State with regard to each other; when brought back, it repels them as before. If, in place of the white, the black be now preſented, the Balls are immediately attracted, ſoon after again repelled, and left once more in a repulſive State with regard to each other. If the white be again preſented, the ſame Train of Effects takes place as before; and ſo on alternately, as in the Caſe of the clear and opaque glaſs Tubes when excited; the white Stockings anſwer preciſely to the clear, and the black to the opaque Tube, and acting, the one *poſitively*, the other *negatively* at full as great a Diſtance, and as forcibly as the Tubes.

Thirdly, Both the Stockings, when held at a Diſtance from one another, appear inflated to ſuch a Degree, that, when highly electrified, they give the entire Shape of the Leg; and when brought near the Face, or any naked Part of the Body, there is a Senſation felt, as if a cool Wind was blown upon that part. When the two white, or two black are held together by the Extremities, they repel one another, and form an Angle, ſeemingly of 30 or 35 Degrees.

Fourthly, When a white and a black Stocking are preſented to each other, they mutually attract, with a Force anſwerable to the Degree of Electricity they have acquired: When brought within the Diſtance of three Feet, they uſually incline towards one another, within two and an half, or two Feet they catch hold of each other; and when brought nearer, they ruſh together with ſurpriſing Violence. As they approach, their Inflation gradually ſubſides, and their Attraction of foreign Objects diminiſhes: When they meet, they flatten, and join as cloſe together, as if they were ſo many Folds of Silk; and then the Balls of the Electrometer are not affected at the Diſtance of a Foot, nor even of a few Inches at certain Times. But what appears moſt extraordinary is, that when they are ſeparated, and removed at a ſufficient Diſtance from each other, their Electricity does not appear to have been in the leaſt impaired by the Shock they had in meeting. They are again inflated, again attract, and repel, and are as ready to ruſh together as before (*a*). When this Experiment is performed with two black Stockings in one Hand, and two white in the other, it exhibits a very curious Spectacle: The Repulſion of thoſe of the ſame Colour, and the Attraction of thoſe of different Colours throws them into an Agitation that is not unentertaining, and makes them catch each at that of its oppoſite Colour, at a greater Diſtance than one would expect. When allowed to come together they all unite in one Maſs; when ſeparated they reſume their former Appearance, and admit of the Repetition of the Experiment as often as you pleaſe; till their Electricity gradually waſting, ſtands in need of being recruited.

Fifthly, When they are ſeparated from one another, they loſe their Power very ſoon, much as the excited Tube does; but when

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(*a*) The Phenomena, here remarked, of the black Stocking and the white, when electrified, namely, that as they approach one another, their attractive and repulſive Force decreaſe with regard to foreign Objects, but increaſe ſurpriſingly with regard to each other, and that their Electricity ſuffers no Diminution from the Shock of their Congreſs, appear to me to be Obſervations new in Electricity, and to merit Attention. They ſeem to point out a retentive Power of Electricity, which takes Place between Electrics, and Electrics only; and which, I apprehend, may be found to be the Cauſe of many curious and ſingular Phenomena.

they are together they will retain it for an Hour or two and longer when the Air is in a ſtate favourable for Electricity. While they are aſunder, and any non-electric is brought near them, if that non-electric is of a broad Surface, it is with Difficulty they are diſcharged of their Electricity; but if the Point of any, eſpecially of a metallic Body, be preſented, they are inſtantaneouſly deprived of their electrical Virtue: But if they be in Conjunction together, they retain their Electricity with ſo much Obſtinacy, that even the ſharpeſt Point of Metal cannot deprive them of it. In this, and in ſome other Reſpects, there appears to be ſuch a Reſemblance between the Leyden Phial, or the electrical Pane of Glaſs, and the black Stocking in Conjunction with the white, eſpecially when the one is within the other, that I have been induced to conſider them both in the ſame Light. In both Caſes, the *poſitive* Electricity is on the one ſide, and the *negative* on the other; and the Stockings as well as the Phial, and the Pane of Glaſs are at once electrified *poſitively* and *negatively*. In both Caſes there is an Accumulation of Electricity, and a Retention of it, far beyond what is to be met with in a ſimple Body, electric or non-electric. There is, however, a very remarkable Difference between them in two Reſpects. In the Phial, and in the Pane of Glaſs, an Exploſion is always obtained by carrying on a Communication between the two Sides by the Interpoſition of a non-electric; but in the Caſe of the black Stocking and the white, I never yet have been able to procure an Exploſion, nor ſo much as a ſpeedy Diſcharge by any Means I could think of, while the one was within the other. I have put one Hand within the innermoſt and with my other have claſped the outward Stocking; nay, I have thruſt in my Hand, and turned the Stockings inſide out, and, in that Condition, have daſhed them againſt the Floor: and all this without producing the leaſt perceptible Diſcharge. On the other Hand, the Phial and the Pane of Glaſs afford no Opportunity of ſeperating the *poſitive* from the *negative* Electricity, ſo as to ſhew them entire and diſtinct from each other; whereas we need only pull the Stockings aſunder, and then in the white we find the *poſitive*, and in the black the *negative* Electricity.

Sixthly, When the Stockings are ſeparated, and in the Dark, upon preſenting to them the Point of one's Finger, or any ſmall metallic Body, round at the End, they exhibit the Appearance of electrical Fire or Light, according to the *negative* or *poſitive* State of the Stocking the Object is preſented to. With the black at the Diſtance of two or three Inches, there appears to dart from the End of one's Finger a Sprig or Pencil, as it were, of fiery Sparks, which dilates in its Progreſs, and ſtrikes againſt the Surface of the Stocking,

ing, at the ſame Time a crackling or ſnapping Noiſe is heard. When the firſt Diſcharge is made, upon preſenting the Finger to a freſh Part of the Stocking, the ſame Phenomenon is repeated till you have traverſed the whole Length of the Stocking, which, when the Finger moves ſlowly, uſually yields eight or ten diſtinct Diſcharges, before it is diveſted of its Electricity. With regard to the white Stocking, the ſame Appearances hold, but with this Difference, that, inſtead of Sparks of Fire iſſuing from the Finger, a little Globule of white or bluiſh Light is ſeen at the Point of it; and, when the Electricity is ſtrong, that little Body of Light ſeems to break in an Exploſion between the Stocking and the Finger; and rather a hiſſing than a crackling Noiſe is heard.

Seventhly, The electrical Phial may be charged by the Stockings either *poſitively* or *negatively*, according as the Wire from the Neck of the Phial is preſented to the white or the black; and in the one, or the other Caſe, the hiſſing or the crackling Noiſe is louder than when any common Wire or non-electric Body is preſented. But if the Electricity of the white Stockings be thrown into the Phial, and upon that the Electricity of the black, or *vice verſâ*; in that Caſe, the Phial will not be electrified at all.

The charging of the Phial was among the firſt of my Experiments with electrified Stockings. By ſome Trials I made in the Month of December laſt, I found it would ſucceed. One froſty Evening in that Month, having thrown into a ſmall Phial, filled with Quickſilver, the Electricity of one black Stocking, I received from the Exploſion a ſmart Blow upon my Finger. With the Electricity of two Stockings, the Blow reached both my Elbows; and by the Means of four, I kindled ſpirits of Wine in a Tea-ſpoon, which I held in my Hand, and, at the ſame Time, I felt the Blow from my Elbows to my Breaſt. It may not, however, be improper to obſerve, that the Electricity, in this Caſe, was excited by Means of the Leg.

From what has been ſaid in the preceding Pages it is evident, that all the remarkable Appearances of Electricity, hitherto diſcovered, may be exhibited by a ſimple Apparatus of black and white Silk. But this is not all, in the Courſe of Experiments above-mentioned, ſomething curious has occurred to my Obſervation, of which I do not find that any Notice has been taken by others.——What I mean is a ſtrong Coheſion produced by Electricity. But as this Paper is already extended to a great Length, I ſhall reſerve the Account of electrical Coheſion for another, which I ſhall ſoon have the Honour of preſenting to the Society."

PAPER III.

Of Electrical Coheſion.

Read *June* 21ſt. 1759.

" ACCORDING to what I promiſed in the Concluſion of my laſt Paper, I come in this to give the Society an Account of Coheſion produced by Electricity. I had not made any great Progreſs in the Series of Experiments and Obſervations I have already had the Honour to communicate, before I perceived that the black and white Stockings, when electrified, and allowed to come together, not only joined extremely cloſe, but actually ſtuck to each other; inſomuch that unleſs when weak in Electricity, or improperly applied, I could make the white bear the weight of the black, or the black that of the white, and that for a conſiderable Time. But as the Weather, for ſome Months in Winter, was ſo ſeldom favourable for electrical Experiments, that I had ſcarcely Opportunities ſufficient to ſatisfy myſelf with regard to other points, I did not enter upon an Examination of this Phenomenon experimentally, till about the latter end of March. By that Time I had got ready the Scale of a Balance properly fitted with a Hook to catch hold of the Stocking, a Set of Troy-weights I could depend upon, and an exact Pair of Scales, to take the preciſe Weight of the Stockings as Occaſion ſhould require.

By Experience, I found that the ſame Pair of Stockings did not always do equally well, even independently of the Weather; and that by being too frequently electrified at a Time, their Virtue appeared to diminiſh. I therefore judged it proper to be provided with Changes of Pairs; and that there might be the greater Conformity between the Experiments, I choſe them, as exactly as poſſible, of the ſame ſize and ſubſtance. The ſort I fixed upon is what is called Half Gauze, the Weight of the white Stocking, at an Average, 18 Penny-weights and 10 Grains; but when dyed black 1 Ounce and 1 Penny-weight, the Weight being increaſed by the dying of that Colour above 5 Penny-weights in the Pair. When the white and the black Stockings were warmed at the Fire, ſo as to be prepared for Electricity, they uſually loſt about a twentieth Part of their Weight; ſo that in the Courſe of my Experiments, I rate the white at 17 Penny-weights and an Half, and the black at 1 Ounce. The Scale, with the ſilk Lines that belonged to it, and the Hook, was adjuſted preciſely to the Weight of 1 Ounce; and as I commonly meaſured the ſtrength of Coheſion by fixing the Hook to the black Stocking, and taking hold of the white, I had but to make an Allowance of two Ounces more than the Weights put into the Scale, ſo as to take the preciſe weight the Stockings could raiſe by the Power of Coheſion.

I meaſured this Power two different Ways; the firſt, while the one Stocking was ſtill within the other; ſecondly, when ſeparated, and the one afterwards applied externally to the other. In the firſt of theſe Caſes, it may be thought that an Allowance ſhould be made for the Friction in pulling the Stockings aſunder; but that appeared to me to be very inconſiderable, for when thoſe of the ſame Colour were put one within the other and inverted, they dropped aſunder of themſelves; or if there was any Entanglement about the Heel, a little ſhaking diſengaged and ſeparated them: However, if it ſhould be thought proper, the Allowance of an Ounce may be made, by deducting ſo much from the Weight reſpectively found.

I have but one Circumſtance more to mention before I proceed to give the Reſult of my Experiments; which is, that we muſt not be ſurpriſed when we find the Force of Coheſion externally to be in no more regular Proportion than that within; for when the Stockings are highly electrified, they ruſh with ſuch Impetuoſity, that it is extremely difficult to direct their Motion, and make them meet in the Manner moſt advantageous for Coheſion.

In the Experiments I have made to meaſure the Force of electrical Coheſion, I have always found it anſwerable, ſo far as I could judge from Appearances, to the Degree of Electricity at the Time excited. When the Stockings have been but weakly electrified, I have found them unable to ſupport the weight, the one of the other. When in a more powerful State of Electricity, I have known them to raiſe, reſpectively, from *one* to *twelve* Ounces, and upwards; nay, once I found the Coheſion ſo ſtrong as to move *ſeventeen* Ounces, including the Scale and the black Stocking. For the ſake of Accuracy, I ſhall give a particular Account of the Reſult of a few of my moſt remarkable Experiments, as I find them in the Notes, which I took at the Time of making them.

The firſt I find is of the 30th of March, the Wind at north-eaſt, the Weather clear, inclining to froſt. The white Stocking within the black raiſed the Weight of one Pound one Ounce ſix Penny-weights and an half, half a Penny-weight more ſeparated them. I find no note here taken of the Weight born by the Stockings applied externally to each other.

April 6th, a hazy and wet Morning; but the Wind at North-eaſt. With new Stockings, the white being within the black, raiſed eleven Ounces—without ſix Ounces. With another Pair that had been much uſed in Experiments,

periments, the white within raiſed ſix Ounces —without three Ounces.

April 16th, a clear dry Morning, the Wind at north-eaſt, Fahrenheits Thermometer at 48. Of the new, the white Stocking within raiſed one Pound five Ounces—without, ſix Ounces fifteen Penny-weights. Of the old, the white Stocking within raiſed eight Ounces—without five Ounces fifteen Penny-weights.

The force with which the black and the white Stockings cohere is not the only Thing remarkable in their Junction. The Solution of that Coheſion, and the different Degrees of Tenacity according to different Circumſtances afford ſome curious Obſervations.

When the black and the white Stockings are in Coheſion with each other, if another Pair, more highly electrified, be ſeparated, and preſented to the former, ſtill in Conjunction, the black to the white and the white to the black, in that Caſe the Coheſion of the firſt Pair will be diſſolved, and each Stocking of the ſecond will carry off that of its oppoſite Colour adhering to it. If the Degree of Electricity of both Pairs be equal, the Coheſion of the firſt Pair will be weakened, but not diſſolved, and all the four will cohere, forming, as it were, one Maſs. If the ſecond Pair be but weakly electrified, the Coheſion of the firſt Pair with one another will be but little impaired; and that of the Stockings of the ſecond with thoſe of the firſt will be weak in proportion. And laſtly, if the ſecond Pair be not at all electrified; or if, in their Place, any other Body not electrified be preſented, there will be no Effect produced on either hand.

White Silk and black, when electrified, not only cohere with each other in the Manner ſhewn above; but, in a high Degree of Electricity, are found, both one and the other, to adhere to Bodies of broad and even, or poliſhed Surfaces, tho' thoſe Bodies be not electrified. This Adheſion I diſcovered accidentally. While I was about ſome electrical experiments, having, without Deſign, thrown a Stocking that was highly electrified haſtily out of my Hand, I was ſurpriſed to find it, ſome Time after, ſticking againſt the Paper Hangings of my Room. This led me to make the following Experiments.

I preſented the white and the black Silk, highly electrified, and in Coheſion with each other, to the Hangings, but no Effect was produced. I then ſeparated the black from the white, and preſented them ſingly; in that caſe each of them readily adhered to the Hangings, which they did when flung from a little Diſtance, and continued there for near an Hour before they dropped. Having ſtuck up the black and the white, in the manner above mentioned, I came with another Pair of Stockings highly electrified, and applying the white to the black, and the black to the white, I carried them off from the Wall, hanging on thoſe that had been applied to them. When the ſecond

Pair were electrified but to a moderate Degree, on applying them in the Manner above deſcribed, the former immediately quitted their Hold of the Hangings, and dropped to the Ground. The ſame Experiments held with painted Boards of the Room, and likewiſe with the Looking-glaſs; to the laſt of which both the black and the white Silk appeared to adhere more tenaciouſly, than to either of the former.

Having been told by one of my Friends, that they had tried ſome of my Experiments mentioned in the preceding Papers, but could not get them to ſucceed: I beg leave to add a few Words before I conclude, by Way of Caution to any, who may have a Curioſity to verify my Experiments.

However eaſy it may ſeem to be to follow the Directions I have already given in electrifying the Stocking; I am ſenſible from my own Experience, that an Attention to a Number of little Circumſtances, beſides ſome ſmall Degree of Addreſs, is requiſite, in order to make it ſucceed readily. This is known to have been the Caſe with the electrical Tube and Globe: Few People, at firſt, knew how to manage them ſucceſsfully; and yet Glaſs is not ſo much expoſed to many Inconveniencies, that affect Electricity, as Silk. To give but one Inſtance of this: We know that a very ſmall Quantity of Duſt or Greaſe, or any other Matter that ſticks to the Tube, will injure its Electricity:

Now this is what may eaſily be wiped off from Glaſs; but it may be very difficult to clear the Silk of it, as Silk is of a Nature more apt to imbibe, and retain extraneous Matter than Glaſs.——From theſe Conſiderations I ſhould not be ſurpriſed at any Perſon's being diſappointed, as to the Succeſs of their Experiments, in a few Trials; but I ſhould think it not fair for them to conclude from thence, that thoſe above recited are not to be depended upon (*a*). Yet if any Member of the Society, who is curious in theſe Matters, hath not been able to ſatisfy himſelf with regard to any particular Experiment, I ſhall think it no Trouble to ſhew him, at any proper Time, how it ſucceeds with me."

(*a*) The Circumſtances neceſſary to be attended to, in order to procure the moſt conſiderable Appearance of Electricity are as follow. 1ſt, That the Wind be in the North, North-eaſt, or Eaſt, the Weather clear and froſty, or inclining to froſt. 2dly, That the Stockings be of Silk; one of a good black, the other of a clear white, and both of the ſame Size and Subſtance. 3dly, That they be new; or kept carefully wrapt up in Paper, and only uſed in electrical Experiments. 4thly, and laſtly, That they be dried before the Fire, and warmed to about the Degree of Heat of the human Body, before they be drawn upon the Hand or Leg. And when taken off, care ſhould be had in ſeparating them, ſo as to keep them at a Diſtance from one's Cloaths, or any Thing that may leſſen their Virtue. The Circumſtances above-mentioned, might be gathered from what has been ſaid in theſe Papers, but I thought it not amiſs to bring them together in this Note.

A LETTER

A LETTER

From *J. Mitchell*, M.D. *F. R. S.* to the Rev. Dr. *Birch*, Secretary to the Royal Society, concerning the Force of *Electrical Coheſion.*

Read *December* 20th. 1759.

SIR,

"I Happened to be at Mr. *Symmer*'s on Saturday the 15th Inſtant, when he deſired me to be a Witneſs to ſome electrical Experiments he was about to make with ſilk Stockings of a particular Kind, which he had received for that Purpoſe.

The Weather was then remarkably favourable for Electricity, being clear and dry, with a ſharp Froſt, which had continued five or ſix days. The Wind was eaſterly, and had been in that Quarter for ten Days. It was about Noon when we made our Experiments; the Barometer at 30, and *Fahrenheit*'s Thermometer at 32.

The Stockings above-mentioned were woven of carded and ſpun ſilk, and were more ſubſtantial and weighty than thoſe with which he had made the Experiments mentioned in his third Paper. One Pair was of a deep black, having been twice dyed in order to improve the Colour. Another Pair was of the natural

Colour of the Silk, of a duſky white, and both new.

The Pair of black weighed 4 Ounces 8 Penny-weights and 4 Grains; and the white 3 Ounces 18 Penny-weights and 15 Grains.

We began with making a few Experiments with the thin Stockings formerly made Uſe of, and found the Reſult to be much the ſame with what is related by Mr. *Symmer* in his third Paper; that is, we found, that when the white Stocking was put within the black, or *vice verſâ*, and both highly electrified, taking hold of th one, while a Scale with Weights was put to the other, we could raiſe 17 Ounces before the Stockings ſeparated.

We then repeated one or two of theſe Experiments with ſome little Variation of Circumſtances. We turned one of the Stockings inſide out, and put that within the other: The inner or rough ſides of the Stockings being thus together, by which means they took faſter hold of each other, we now found, that it required the Weight of 20 Ounces to ſeparate them.

When the Stockings were ſeparated, and applied externally to each other, they then raiſed the Weight of 10 Ounces.

We next proceeded to try the electrical Force of Coheſion with the Stockings of a more ſubſtantial Make, *viz.* thoſe I have above deſcribed; and there we found it to be much more conſiderable, as appears by the following Experiments.

1. When the white Stocking was put within the black (without either of them being turned inſide out), ſo that the outſide of the white was contiguous to the inſide of the black, they lifted nine pounds, wanting a few pennyweights. Now, taking the Weight of the Stocking to be one Ounce eighteen pennyweights, and fifteen grains (viz the half of the Weight of the Pair as mentioned above), it follows, that by the Force of its Coheſion with the black, it raiſed fifty-five times its own Weight.

2. When the white was turned inſide out, and put within the black, their inner or rough ſides being contiguous, they lifted no leſs than fifteen Pounds one Penny-weight and an Half, before they ſeparated: So that, in this Caſe, the ſingle Stocking raiſed ninety-two times its own Weight.

3. When the inner Stocking was drawn out, and applied on the outſide of the other, they lifted one Pound and three Quarters; that is, between ten and eleven Times the Weight of the white Stocking.

It is not my Deſign to draw any Concluſions from theſe Experiments, and much leſs to determine how far Electrical Coheſion may ſerve, as a Principle, to account for many remarkable Appearances in Nature. I relate the Experiments I have been Witneſs to, by way of Supplement to Mr. *Symmer*'s third Paper; and I conſider the Reſult of them, only, as a farther Proof of the ſurpriſing Degree to which a Power in Electricity, which had not before been attended to, may be carried, in even the ſlighteſt Subſtances, thoſe of white and black Silk.

JOHN MITCHELL."

IN farther Confirmation of the powerful Agency of the Electrical Fluid, if any farther Proof can be required, I will add a Letter from another very ingenious Author, tending to prove not only the Univerſality of the Electrical Fluid, but the ſame Electricity of the Human Body, and that of the Cloaths we wear: — And as a Variety of Paſſages of the former are analogous to many contained in the latter, I ſhall inſert them in this Place.

Theſe EXPERIMENTS are entitled,

Singular Effects of Electricity,

By *P. BRIDONE*, F. R. S.

Which he introduces with Remarks on Vegetation, as follows.

"OF all the Reaſons aſſigned for the wonderful Vegetation that is performed in different Parts of the World, there is in fact none that contributes ſo much towards it, as a conſtant electrical State of the Air. From a Variety of Experiments it has been found, that an Increaſe of the Electrical Matter increaſes the Progreſs of all Vegetation. It probably acts there in the ſame manner as on the Animal Body;—the Circulation we know is performed quicker; and the Juices are driven through the ſmall Veſſels with more Eaſe and Celerity. This has often been proved from the immediate Removal of Obſtructions by Electricity; and probably the rubbing with dry and warm Flannel, eſteemed ſo efficacious in theſe Caſes, is doing nothing more than exciting a greater Degree of Electricity in the Part; but it has likewiſe been demonſtrated, by the common Experiment of making Water drop through a ſmall capillary Syphon, which the Moment it is electrified runs in a full Stream.——I have, indeed, very little Doubt, that the Fertility of our Seaſons depends as much on this Quality in the Air, as either on its Heat or Moiſture."

"Electricity will probably ſoon be conſidered as the great vivifying Principle of Nature, by which ſhe carries on moſt of her Operations. — It is a fifth Element, perfectly diſtinct, and of a ſuperior Nature to the other four, which only compoſe the corporeal Parts of Matter: But this ſubtile active Fluid is a kind of Soul that pervades and quickens every

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Particle of it. When an equal Quantity of this is diffuſed through the Air, and over the Face of the Earth, every thing continues calm and quiet; but if, by any Accident, one Part of Matter has acquired a greater Quantity than another+ the moſt dreadful Conſequences often enſue before the Equilibrium can be reſtored.——Nature ſeems to fall into Convulſions, and many of her Works are deſtroyed.——All the great Phenomena are produced; Thunder, Lightning, Earthquakes, and Whirlwinds: For I believe there is little Doubt, that all theſe often depend on this ſole Cauſe. And again, if we look down from the Sublime of Nature to its Minutiæ, we ſhall ſtill find the ſame Power acting, though perhaps in leſs legible Characters; for as the Knowledge of its Operations is as yet in its Infancy, they are generally miſunderſtood, or aſcribed to ſome other Cauſe. However, I have no Doubt, that in Proceſs of Time theſe will be properly inveſtigated, when Mankind will wonder how much they have been in the Dark. It will then poſſibly be found, that + what we call Senſibility of Nerves, and many of thoſe Diſeaſes that the Faculty have as yet only invented Names for, are owing to the Body's being poſſeſſed of too large or too ſmall a Quantity of the ſubtile and active Fluid; that very Fluid perhaps, which is the Vehicle of all our Feelings, and which they have ſo long ſearched for in vain in the Nerves: For I have

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our Author also attributing
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have ſometimes been led to think, that this Senſe was nothing elſe than a ſlighter Kind of electric Effect to which the Nerves ſerve as *Conductors*; and that it is by the rapid Circulation of this penetrating and animating Fire that our Senſations are performed. We all know, that in damp and hazy Weather, and when it ſeems to be blunted and abſorbed by Humidity, when its Activity is loſt, and little or none of it can be collected, we ever find our Spirits more languid, and our Senſibility leſs acute: when therefore the Air ſeems totally deprived of it, the whole Syſtem is unſtrung, and the Nerves ſeem to loſe both their Tenſion and Elaſticity, till the north or weſt Wind awakens the Activity of this animating Power, which ſoon reſtores the Tone, and enlivens all Nature, which ſeemed to droop and languiſh during its Abſence."

" It is likewiſe well known, that there have been Inſtances of the human Body becoming electric, without the Mediation of any electric Subſtance; and even emitting Sparks of Fire with a diſagreeable Senſation, and an extreme Degree of nervous Senſibility "

" About ſeven or eight Years ago, a Lady in Switzerland was affected in this Manner, but I was not able to learn all the Particulars of her Caſe: However ſeveral Swiſs Gentlemen have confirmed to me the Truth of the ſtory. ——She was uncommonly ſuſceptible of every Change of Weather, and had her electrical

Feelings ſtrongeſt in a clear Day, or during the Paſſage of Thunder-clouds, when the Air is known to be replete with that Fluid. Her Diſeaſe, like all others which the Doctors can make nothing of, was declared to be a nervous one; for the real Signification of theſe Words I take to be only, that the Phyſician does not underſtand what it is."

"Two Gentlemen of Geneva had a ſhort Experience of the ſame Sort of Complaint, though ſtill in a much ſuperior Degree.—— Profeſſor *Sauſſure*, and young Mr. *Jalabert*, when travelling over one of the high Alps, were caught amongſt Thunder-clouds; and to their utter Aſtoniſhment, found their Bodies ſo full of electrical Fire, that ſpontaneous Flaſhes darted from their Fingers with a crackling Noiſe, and the ſame Kind of Senſation, as when ſtrongly electrified by Art.— This was communicated by Mr. *Jalabert* to the Academy of Sciences at Paris, I think, in the Year 1763; and you will find it recorded in their Memoirs."

"It ſeems pretty evident, I think, that theſe Feelings were owing to the Bodies being poſſeſſed of too great a Share of electric Fire. This is a very uncommon Caſe; but I do not think it at all improbable, that many of our Invalids, particularly the Hypochondriac People, and thoſe we call *Malades Imaginares*, owe their diſagreeable Feelings to the oppoſite

Cauſe, or the Body's being poſſeſſed of too ſmall a Quantity of this Fire; for we find that a Diminution of it in the Air ſeldom fails to increaſe their Feelings, and *vice verſâ.*"

" Perhaps it might be of Service to theſe People to wear ſome electric Subſtance next their Skin, to defend the Nerves and Fibres from damp, or non-electric Air.—— I would propoſe a Waiſtcoat of the fineſt Flannel, which ſhould be kept perfectly clean and dry; for the Effluvia of the Body, in Caſe of any violent Perſpiration, will ſoon deſtroy the electric Quality: This ſhould be immediately covered by another of the ſame Size of Silk, but without being ſewed together. The Animal Heat and the Friction that Exerciſe muſt occaſion betwixt theſe two Subſtances, produce powerful Electricity, and would form a Kind of electric Atmoſphere around the Body, that might poſſibly be one of the beſt Preſervatives againſt the Effects of Damps."

" As for our Swiſs Lady, I have little Doubt that her Complaints were owing in great Part, perhaps entirely, to her Dreſs; and that a very ſmall Alteration, almoſt in Part of it, would effectually have cured her. A Lady who has her Head ſurrounded with a Wire-cap, and her Hair ſtuck full of Metal Pins, and who at the ſame Time ſtands upon dry Silk, is to all Intents and Purpoſes an

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an electrical Conductor inſulated, and prepared for collecting the Fire from the Atmoſphere: And it is not at all ſurpriſing, that during Thunder-ſtorms, or when the Air is extremely replete with electrical Matter, ſhe ſhould emit Sparks, and exhibit other Appearances of Electricity. ——— I imagine a very trifling Change of Dreſs, which from the conſtant Verſatility of their Modes may ſome Day take Place, would render this Lady's Diſeaſe altogether epidemical amongſt the Sex. Only let the Soles of their Shoes be made of an electric Subſtance, and let the Wires of their Caps, and Pins of their Hair be ſomewhat lengthened and pointed outwards, and I think there is little Doubt that they will often find themſelves in an electrical ſtate: But indeed, if they only wear Silk, or even Worſted Stockings, it may ſometimes prove ſufficient; for I have often inſulated Electrometers as perfectly by placing them on a Piece of dry Silk or Flannel, as on Glaſs."

"How little do our Ladies imagine, when they ſurround their Heads with Wire, the moſt powerful of all Conductors; and at the ſame Time wear Stockings, Shoes, and Gowns of Silk, one of the moſt powerful Repellents;* that they prepare their Bodies in the ſame Manner, and according to the ſame Principles as Electricians prepare their Conductors for

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for attracting the Fire of Lightning! If they cannot be brought to relinquiſh their wire Caps and their Pins, might they not fall upon ſome ſuch Preſervative as thoſe which of late Years have been applied to Objects of much leſs Conſequence.

"Suppoſe that every Lady ſhould provide herſelf with a ſmall Chain or Wire, to be hooked on at pleaſure during thunder ſtorms. This ſhould paſs from her Cap over the thickeſt part of her hair, which will prevent the Fire from being communicated to her Head, and ſo down to the Ground.——It is plain that this will act in the ſame Manner as the Conductors on the Top of Steeples, which from the metal Spires that are commonly placed there, analogous to the Pins and Wires, were ſo liable to Accidents. You may laugh at all this, but I aſſure you I never was more ſerious in my Life. A very amiable Lady of my Acquaintance, Mrs. *Douglas* of Kelſo, had almoſt loſt her Life by one of thoſe Caps mounted on Wire. She was ſtanding at an open Window during a thunder Storm: The Lightning was attracted by the Wire, and the Cap was burnt to Aſhes; happily her Hair was in its natural State, without Powder, Pomatum, or Pins, and prevented the Fire from being conducted to her Head; for as ſhe felt no Kind of Shock, it is probable that it went off from the Wires of the Cap to the

Wall, cloſe to which ſhe then ſtood. If it had found any Conductor to carry it to her Head or Body, in all Probability ſhe muſt have been killed.—A good ſtrong Head of Hair, if it is kept perfectly clean and dry, is probably one of the beſt Preſervatives againſt the Fire of Lightning. But ſo ſoon as it is ſtuffed full of Powder and Pomatum, and bound together with Pins, the repellent Force is loſt, and it becomes a Conductor (*a*). We have it ever in our Power to be making Experiments in Electricity. And although this Fluid is the moſt ſubtile and active of any that we know, we can command it on all Occaſions; and I am

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(*a*) Since the writing of this, the Author has made ſome Experiments on the Electricity of Hair, which tend ſtill to convince him yet more of the Truth of what he has advanced.

A Lady had told him, that on combing her Hair in froſty Weather, in the Dark, ſhe had ſometimes obſerved Sparks of Fire to iſſue from it This made him think of attempting to collect the Electrical Fire from Hair alone, without the Aſſiſtance of any Electrical Apparatus To this End, he deſired a young Lady to ſtand on a Cake of Bees-Wax, and to comb her Siſter's Hair, who was ſitting on a Chair before her.—Soon after ſhe began to comb, the young Lady on the Wax was greatly aſtoniſhed to find her whole Body electrified; darting out Sparks of Fire againſt every Object that approached her. The Hair was extremely electrical, and affected an Electrometer at a very great Diſtance: He charged a Metal Conductor from it with great Eaſe; and in the Space of a few Minutes collected as much Fire immediately from the Hair, as to kindle common Spirits; and by means of a ſmall Phial gave many ſmart Shocks to all the Company. A full Account of theſe Experiments was lately read before the Royal Society. They were made during the Time of a very hard Froſt, and on a ſtrong Head of Hair, where no Powder or Pomatum had been uſed for many Months.—See the Univerſal Magazine for May, 1773, p. 250.

am now ſo accuſtomed to its Operations, that I ſeldom comb my Hair, or pull off a Stocking, without obſerving them under ſome Form or other. How ſurpriſing is it then, that Mankind ſhould have lived and breathed in it for ſo many thouſand Years, without almoſt ever ſuppoſing that it exiſted!"

Before I conclude my Obſervations on the preſent Subject, I cannot help remarking the great Satisfaction and Pleaſure attending the Thought of being gotten into the Track that leads to true Science. This made me think of the yet much greater Pleaſure and Happineſs, that muſt follow from a Succeſſion of ſuch pleaſing Ideas. Theſe Thoughts brought to my Mind a periodical Paper that I had formerly read, entitled the *Free Enquirer*, wherein that Author attempted to diſplay the future Happineſs of intellectual Beings. The Conjectures of the Writer on the ſame Head afforded ſuch a Variety of pleaſing Ideas of Knowledge and Happineſs in a future State, that it prevailed with me to treat my Reader with it, expecting it would afford him the ſame pleaſant Repaſt that it did to me.

KNOWLEDGE is the Characteriſtic whereby we are diſtinguiſhed from the *brute* Creation. And altho' we are told by the wiſeſt Man, that he who increaſeth Knowledge increaſeth Sorrow; yet we are not to infer from thence that Science is an Object unworthy of our Purſuit, but only that our higheſt intellectual Acquirements in this World are partial and unſatisfying; and that after our moſt aſſiduous Application we ſhall find, to our Sorrow, that altho' we may have learned much, yet many more Things ſtill remain, which cannot be fathomed by the ſhort Line of human Underſtanding: However, it muſt be allowed, that Knowledge is productive of a proportionable Degree of Pleaſure, and an uninterrupted Succeſſion of it would be the neareſt Approach to perfect Happineſs.

"THERE is ſcarce any Thing," ſays the ingenious Author of the *Free Enquirer*, "more agreeable, than to conſider the gradual Riſe and Improvement of the human Species. At firſt they are Infants, weak and helpleſs, with no Appearance of any rational or moral Powers; and were a perfect ſtranger to the Race, and to our World, to obſerve them then, it would appear very unlikely to him, if not impoſſible, they ſhould come to be the

Creatures they afterwards are. From Babes they riſe to Childhood; from Childhood to Youth, and all the while their Faculties inſenſibly open, their Powers unfold themſelves, they learn Habits and Experience, till at length they are fitted for, and arrive at Manhood, where their intellectual and moral Capacities ſhew themſelves in their full Strength, and Scope and Opportunities are given for the Exerciſe and Improvement of them. After this, when by means of the Probation and Diſcipline of Life, their Characters are formed to Virtue; and when the moral Principle is raiſed to its due State of Influence, and the requiſite Temper and Preparations for a higher State of Being and Bliſs are acquired; they are taken from hence; they drop their preſent Frailties and Imperfections; they exchange Earth for Heaven, and riſe from the Rank of Men to that of Angels.—It is very natural to reflect here on the Wiſdom and Goodneſs of God, in cauſing our Exiſtence to be thus progreſſive; in making one Stage of our Being a Preparation for another; and not introducing us into any larger Spheres of Action and Enjoyment, before we are in a proper Manner qualified for them.

But what I have chiefly in view at preſent is, to take Notice, that our Progreſs will by no means end with this Life; and that our next Advance will not be our laſt and final one; but that, moſt probably, we ſhall always be in a

Progreſs of Being, and for ever advancing. It ſeems quite unreaſonable to ſuppoſe, that good Men will hereafter get to a Point beyond which they cannot go; or that a Period can ever arrive when an entire Stop will be put to their Enquiries and Improvement, and nothing further of Good, or Knowledge, or Virtue and Perfection can be expected. That all, that we perceive, of our Exiſtence is Progreſſive, affords a Preſumption that it may be ſo throughout. The Nature of the Soul of Man is evidently ſuch, that it appears capable of improvements to which we can ſet no Bounds. It may have various Faculties, now latent, which in another World are to appear, and innumerable Powers, Sources, and Capacities of Pleaſure, which hereafter, in their proper ſucceſſive Periods, will be for ever ſpringing forth and exerting themſelves: And who knows what Degrees of Bliſs the unfolding of one new Faculty may occaſion? What additional Dignity, full Scope for the Exertion of one new Power may give us? And what Laws and Scenes of Nature, now inconceivable to us, one ſuperadded Senſe may diſcover to us? There may be alſo innumerable Regions and Diſtricts of this Univerſe, each of them ſurpaſſing unſpeakably, and thro' an endleſs Progreſſion, the other in Glory; to the View and Contemplation of which we may in due Succeſſion, and as we grow more capable, be always riſing; but all or any proportionable Part of which it will not be poſſible for us ever to ſee, and get acquainted with. — There is, farther, an Infinity of abſtract Knowables; and, in ſhort, Truth and Being; the amazing Scenes of Nature; the poſſible Objects of our Minds; their Wiſhes and Powers; and the Divine Nature and Perfections, are boundleſs and inexhauſtible. There appears then nothing to ſtop our Progreſs. We have infinite Room to expatiate in, and Scope for eternal Advances.— Suppoſe, therefore, what is now pleaded for, to be Fact; and it will be evident, that it is ſaying nothing, to affirm that a Time muſt come, when there will be a greater Difference between what we ſhall be then, and what we are now, than between the firſt Archangel and the meaneſt Reptile; when, to take in, and ſurvey this whole Globe, or even Syſtem, will perhaps be no more to us, than it is now to obſerve what paſſes in the ſame Room with us. There would appear nothing incredible in this, if Perſons would but conſider, that by going on to improve, let it be ever ſo ſlowly, through infinite Ages, we muſt make more and higher Acquiſitions, and come to greater Degrees of Knowledge, Goodneſs, Wiſdom, Power, and Perfection, than any which it is now poſſible for us to aſſign or imagine; that this Earth, nay probably this whole viſible Frame of Sun and Stars, compared with the Immenſity of the Creation, is but a Point, and that nothing finite bears any Proportion to what is infinite.

From thus viewing Things forwards, and conſidering the future Progreſs of reaſonable Beings, I cannot help taking Occaſion to turn my Thoughts backwards, and obſerving that there muſt undoubtedly exiſt Beings who were the firſt Productions of the Divine Power; that the Time which has intervened ſince theſe received their Exiſtence (tho' it ſhould be allowed impoſſible to be properly Infinite) yet is in all probability Indefinite; that thro' this whole immeaſurable Length of Duration, they have been growing and improving, and conſequently muſt e'er now be arrived at Degrees of Intelligence, Dignity, and Excellence, that are above all human Conception—For my part, I am well convinced, that even after our utmoſt Endeavours to the contrary, we are apt to entertain much too low Ideas of the Syſtem of the Creation, and the poſſible, nay actual Dignity and Grandeur of intellectual Beings. It muſt not be forgot, however, that how highly ſoever we conceive of reaſonable Creatures, and whatever Degrees of Superiority and Perfection we believe they may poſſeſs; yet they are, and (after the farther Improvement of numberleſs Ages) muſt ever continue, all equally dependent upon, and inferior to the Creator; all (ſtrictly ſpeaking) equally nothing, compared with him; and at the ſame, that is, an infinite Diſtance from original, neceſſary, abſolute Perfection.

But to return to the Contemplation of our own Natures and Hopes: Upon any Notion of the future State, it muſt be true, that we are now as incapable of forming any Idea of what we are to be in it, as a Child in the Womb is of forming an Idea of the State, Employment, and Happineſs of a grown Man. But take in the Conſideration that we are to be always improving; and it will appear, that, in no aſſignable future Period of our Exiſtence, we ſhall be able to conceive what we are further to be, in the Periods beyond that.

Here I find it almoſt impoſſible to reſtrain myſelf.—To be eternally aſcending in the Scale of Being! How high then ſhall we at laſt reach! And, tho' always happy to the utmoſt Extent of our Wiſhes, yet not to be able to imagine, in any Part of our future Being, how much more happy, great, and good, we are to be! What a Proſpect is this! How vaſt! How aſtoniſhing!

Theſe Obſervations naturally give Occaſion to enquire, 1ſt. Whether it is credible, that Beings, who can thus extend their Views and Hopes through Eternity, and are capable of ſuch a Progreſs, ſhould be deſigned for a low, momentary Exiſtence here; ſhould all periſh in the firſt Step of their Progreſs; and after juſt ſhewing themſelves to the World, and being curſt with the Idea and Wiſh of Immortality, ſink into Oblivion and Annihilation?

In the next Place, how can we ſufficiently adore the Goodneſs of God, in bringing us into Being; in placing us in ſuch a Rank amongſt his Creatures, and ſetting before us ſuch a Proſpect?

Further; how unſpeakable does the Dignity of human nature appear when thus conſidered? What reaſon have Mankind to reverence themſelves! And how proper and important Objects are they of that extraordinary Interpoſition and Apparatus to ſave them, which Chriſtianity reveals? Every Particle of Matter in the Univerſe is continually acted upon by the Deity; but one human Mind, with ſuch Capacities as have been repreſented, is infinitely ſuperior in Value to the whole material Univerſe; and the Ruin of it, of infinitely greater Conſequence.

Again; how dreadful a thing is Vice, which ruins ſuch noble Beings, indiſpoſes them for the Happineſs of their Natures, and bereaves them of all their high and infinite Hopes? It is undoubted, that Virtue and Righteouſneſs are, and muſt be, the only Qualifications for Bliſs, under the Government of a Righteous Being. I am ſure no wiſe Perſon will ſlight this Obſervation. For though the Probability were ſuppoſed greatly againſt its being true; though the Preſumption were ever ſo ſmall for the Reality of ſuch a State of ever growing Bliſs as I have deſcribed, which Vice in any Degree endangers the Loſs of; it would ſtill, demonſtrably, be the extreme of Madneſs not to reſign all for the Sake of it, and not with the greateſt Anxiety to avoid what may, any way, tend to diminiſh our Chance for it.

Finally; ſuch Reflections as thoſe above made, ſhould, ſurely, raiſe us above this World, and leſſen our Attachment to it. How ſad is it to ſee the Heirs of ſuch Hopes wallowing in the Mire, and revelling with Brutes! How unnatural for Minds which the whole World cannot buy, that can take in the Univerſe, and were born for Eternity, to contract their wiſhes and regards to a point, and an inſtant!

We are to outlive the Sun and the Moon. What an Elevation and Dignity ſhould the View of this give to our Behaviour? How ſhould the unbounded Proſpect looſen us from the Earth, and give Wings to our Minds! How ſhould we trample on the Tinſel of Life, and anxiouſly avoid every thing unbecoming our vaſt Expectations! What can we think of thoſe groveling Souls who forget their higher Country; who diſgrace their heavenly Original; who can contentedly look forward to Annihilation; whoſe Ambition riſes no higher than the preſent State; and who abandon the common and rational Hope of Mankind concerning a future Immortality? Theſe renounce the noble Principles and Aims of all that are worthy to be reckoned Men, and ſhould indeed be looked upon as Betrayers of their Intereſts, as Traitors to the Species, as Fugitives from the Rank and Station, the Dignity and Privileges of reaſonable Beings;

and ought to be treated with ſuitable Scorn and Contempt.

To conclude: Human Life conſidered in itſelf, and compared with our whole Duration, and unlimited Capacities and Hopes, is indeed ſo little and low a Thing, that it ſcarcely deſerves the Name of Exiſtence; and it is abſolutely of no Moment what befalls us in it, any farther than it affects our Tempers and moral Characters. and helps or hinders our Meekneſs for what comes after it. Its Riches, Pleaſure, Power, and all that is commonly courted and purſued by unthinking Mortals, are unworthy a ſingle Wiſh, or Thought of a well informed Mind, or of one who believes, or but ſuſpects it poſſible, that he is to live for ever.

And here I cannot but remark with concern, that notwithſtanding we appear thus capable of ſuch a bliſsful Succeſſion of future tranſcendent Knowledge, yet ſo long as we remain in this Life, we are too apt to be wedded, as it were, to *ſenſual Pleaſures*, and to have but little reliſh for *intellectual Enjoyments*. But ſurely if we reflect a Moment on the vaſt Diſparity which is between them, how unſatisfactory the very Fruition of the former is, and how ſhort their Duration; whilſt the Joys of the latter are refined and permanent, and conſtantly advancing in a gradual Progreſſion towards Perfection, we cannot, without Reproach to our Reaſon, make ſo abſurd a Choice as to give the Preference to thoſe which are leſs valuable.

CON-

CONCLUSION.

I Shall conclude this Supplement with obſerving, that as there is but one true Religion, ſo neither is there more than one true Philoſophy. Truth being always uniform and conſiſtent with itſelf.

" It is impoſſible," as the Rev. and learned Mr. *Jones*, in his Firſt Principles of Natural Philoſophy, religiouſly obſerves, " that true ' Religion and true Philoſophy ſhould be at ' Variance; becauſe He, who created all thoſe ' Works, which are the proper Objects of ' Natural Philoſophy, was alſo the Author of ' Divine Revelation, and God is not divided ' againſt Himſelf."

True Philoſophy, according to former Profeſſors, is founded on an univerſal Vacuum and a mutual Attraction of the Parts of Matter, in order to account for their mutual Tendency towards each other: But ſince the Commencement of modern electrical Experiments, an elaſtic ſubtile Medium or Æther is diſcovered to exiſt; from the Effects of which, electrical Philoſophers can produce undeniable Evidence to prove, that, inſtead of an abſolute Vacuum and a mutual Attraction to cauſe ſuch Tendency, an abſolute Plenum exiſts and an impelling Force: Since therefore one of them only can be true, they humbly propoſe, that in order to decide the grand Point, a ſtrict Scrutiny may be made into the Merits of both, which being once done, Philoſophers will no longer halt between two ſuch different and contradictory Opinions; but we ſhall then go Hand in Hand, and proceed in our phyſical Reſearches with Perſpicuity and Pleaſure.—As ſuch a ſtrict Examination can injure neither Party, 'tis preſumed no impartial Enquirers can reaſonably reject the Propoſal; and the Motive which can prevent ſuch a ſtrict Examination, muſt ſavour ſtrongly of invincible Prejudice.

Unleſs ſuch a deciſive Method be purſued, and electrical Philoſophy be throughly examined, as propoſed, the current Philoſophy muſt neceſſarily remain where Sir *Iſaac Newton* left it, which, as he informs us in the Preface to his Principia, was then in an intricate State, and that Philoſophers attempted the Search of Nature in vain (*a*); intimating alſo at the ſame Time, that the received Philoſophy was *not a true one*. And they ſeem not yet much more inclined to attempt the Search of Nature upon any other Plan than that which they have ſo

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(*a*) Electrical Philoſophers are certain that it was out of the Power of Philoſophers to attempt the Search of Nature with Succeſs, before a more ſubtile elaſtic Medium was diſcovered to them than that of the common Air.

long and ſo unſucceſsfully purſued; and not any, beſides a few electrical Philoſophers, attempt to explain it, at the preſent, on any other Principle, notwithſtanding the Length of Time the electrical ſubtile Medium has been diſcovered, and our intimate Familiarity with it by Means of the numberleſs Experiments which have been made upon it; and yet we ſeem almoſt as much unacquainted with it as ever: For go into what Company we will, if Electricity happens to be the Topic of Converſation, nothing is more common than to hear Men expreſſing the greateſt Admiration concerning it, aſking us, What can it be? Whence does it proceed? And how do you account for that ſurpriſing Power and Force which we behold in moſt of the Experiments?—And what is very remarkable, not only common People thus interrogate, but the learned and ſagacious.

Electrical Philoſophers ſolve thoſe formidable Difficulties by Principles previouſly proved; *i. e.* that the electrical Fluid is an univerſal Fire in the Form of an extremely fine and pure elaſtic Air. That all Nature is neceſſarily replete with it, inſomuch that an abſoluee Plenum of it becomes the natural Conſequence. That by Means of its Force and Action, all the abſtruſe Phenomena exhibited in the Experiments are ſolved. They moreover produce undeniable Evidence, to prove that this elaſtic Fire acts on all other Bodies with an impelling Force.

But in order to render this Method of reaſoning yet more ſatisfactory, I muſt ſubjoin the ſix fundamental Articles contained in my Eſſays, p. 22, that the Readers of the preſent Work may have them ready at Hand, to conſult in their Reſearches upon all Occaſions.

Firſt, That in the Beginning, the ALL-WISE and OMNIPOTENT CREATOR of all Things formed an univerſal æthereal Fluid or primary Air, endued with the utmoſt Purity, Subtilty, and Rarity; and, in fine, a perfectly ſubtile elaſtic Fluid.

Secondly, That the whole Univerſe is replete with it; for otherwiſe a Fluid ſo perfectly ſubtile and elaſtic would be perpetually expanding, till all Parts were equally full: And then, neither the whole, nor its Parts, could remain endued with that perfect Elaſticity which was at firſt ſuppoſed, and at preſent appears to be.

Thirdly, That this Æther or pure Air is univerſal, not only in all open Spaces, but in the minuteſt Vacuities of the moſt compact Bodies; by Reaſon of its being compoſed of almoſt infinitely finer Particles than thoſe of groſs Matter; which renders it capable of permeating the ſmalleſt Pores and Inſterſtices of the hardeſt and cloſeſt Subſtances.

Fourthly, Since the Earth is endued with a Property of Tranſpiration, or of breathing forth the moſt volatile Parts of it to a conſiderable Height from its Surface; thoſe Effluvia become blended, incorporated, and moſt intimately mixed with Particles of the univerſal pure Æther or primary Air, and by that Means conſtitute a ſecondary Air (*a*), or aëriel Fluid, and the only one that could (till now) be proved to exiſt.

Fifthly, That from the Elaſticity of its Particles ariſeth an Intumeſcence, a ſwelling or expanding Property, and conſtant Endeavour of extending their Limits to greater Dimenſions: Hence they, and conſequently all Maſſes compoſed of ſuch elaſtic Particles, mutually repel.

Sixthly and *laſtly*, That this univerſal Air, although inviſible, is nevertheleſs true and real Fire in the ſtricteſt Senſe of the Word, and endued with the utmoſt Force.

Theſe Articles were at firſt propoſed as a Theory only, and having for ſeven or eight Years paſt been ſtrictly and repeatedly examined without the leaſt degree of Prejudice, by the Author, who cannot find any Reaſon to alter his Sentiments; 'tis therefore preſumed they are juſtly founded, and may be ſafely carried into Practice.

What I mean by Theory and Practice is, that having been verſed in a Theory for ſeven Years, it muſt then be high Time to attempt the Praxis: That is, after having purſued the analytical Method to a ſufficient Lenght, we may fairly proceed to the ſynthetical; *viz.* we may then reaſon *a priori*.

(*a*) Atmoſphere.

B. Our greateſt Naturaliſts ſeem unanimouſly to explode *that* Method of reaſoning in their phyſical Reſearches. The grand Hypotheſis of *Des Cartes* being founded entirely on *a priori*, might poſſibly be one principal Cauſe for rejecting the whole: But can you aſſign any Reaſon more ſubſtantial?

A. Before the Diſcoveries that have been made by means of the electrical Apparatus, we had no other ſafe Way of advancing than by reaſoning *a poſteriori*; there was then no other Method to inveſtigate the Cauſe: Whereas the Means which are afforded us from Electricity having diſcovered it, we may now ſafely proceed with Preciſion and Certainty in the other Way; namely, from the Cauſe to the Effect.

Your Obſervation on *Des Cartes* in particular ſeems indeed to be juſt, as his Syſtem was very exceptionable on that Account; it being merely arbitrary, and without any proper Foundation for its Support.

B. What have the electrical Philoſophers that is more unexceptioable, whereon to found *their* Method of reaſoning *a priori?*

A. That which no Age before was ever in Poſſeſſion of: *viz.* The firſt Mover among ſecondary Cauſes is now realized, and become clearly known to us as a permanent Principle, under the Form of pure Fire.

N. B. I have been the more explicit on this Subject, in order to ſhew that there was no other than that *backward* Way of proceeding in our phyſical Reſearches with Succeſs, before Fire, that firſt mechanical Agent, was diſcovered.

A Glimpſe of this unknown ſomewhat in Bodies, was diſcovered by means of the pneumatic Engine, and afterwards clearly confirmed and verified by the electrical Engine, and is the grand Agent which has ſo amazed Mankind, and which is found capable of ſolving all thoſe otherwiſe inexplicable Difficulties.

Every Spectator of the Experiments plainly diſcovers it to be true Fire; but the electrical Philoſophers, by means of an indefatigable and ſtrict Examination of it for a Series of Years paſt, have at length found it to be an univerſal Fire in the ſtricteſt Senſe, not only in the Pores of all groſs Bodies, but, conſequently, in all free and open Spaces.

In a Word, if the current Philoſophers can ſupport their Doctrine of an univerſal Vacuum and an attracting Force in a more rational and ſatisfactory Manner, electrical Philoſophers will not only publickly acknowledge their Miſtake, but will think themſelves highly indebted for the Means of their Conviction. But, on the other Hand, if the Doctrine of an electrical Plenum cannot be refuted and fairly ſet aſide, they appeal to all the judicious and impartial Enquirers after Truth, whether that be not a ſtrong Preſumption in their Favour, that their Scheme is well founded.

POSTSCRIPT.

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A. YOU may probably recollect that I never made any Reply to the Animadverſions of the Monthly Reviewers on my printed Letter to them: My Reaſon for it was, that I never deſigned to have troubled myſelf nor the Public with any more of their impertinent Cavils; but their Animadverſions on my Philoſophical Eſſays were of too inſolent and flagitious a Nature to be paſſed by unnoticed.

B. I cannot ſay I remember it, and therefore pleaſe to proceed.

A. At Page 26th of that Letter, I informed thoſe Writers, that as "I had then gone thro' their Animadverſions in the Manner I propoſed at the Beginning of it, I ſhould take Leave of them at that Time; and unleſs they would conſent to carry on the ſame kind of Correſpondence by the Channel of their monthly Paper, I ſhould take a *final* Leave, ſince it muſt be obvious to every one how impracticable a Thing it was to write and publiſh a Pamphlet or a Letter every Time they might think proper to raiſe an Objection (*a*). But if they ſhould re-

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(*a*) Every Author is very ſenſible of the Trouble and Difficulty it muſt be, excluſive of the Expence of a Performance from the Preſs; and even after that he may juſtly deſpair of any ſmall Thing becoming very public. Thoſe Writers being ſenſible of theſe Things, and as I had informed them that I ſhould, for ſuch ply as formerly, that it was not conſiſtent with the Plan they had formed, or for Want of Room, &c. poſſibly it might be thought an evaſion merely to ſhift off the Force of the Argument; and therefore, if they had that ſincere Regard for Science which they frequently expreſſed, they could have no juſt Reaſon to reject the Propoſal of carrying on ſuch a Correſpondence in the Manner above mentioned."

" By thus continuing an amicable Communication of Sentiments on the Subject of Electricity, ſomething acceptable might be reaſonably expected. We may then, if neceſſary, reſume the ſame Things. For altho' I am entirely convinced as to the Repulſive Scheme, yet the Word Attraction could not, as I then thought, be wholly diſuſed, particularly, when I conſidered the Accumulation on the Glaſs Tube or Globe, or in the electrical Phial, as alſo, how light Bodies are moved with ſuch Rapidity to the Body electrified, without ſuppoſing ſome Kind of Attraction (*a*). If thoſe and the like

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like Reaſons take a final Leave of them, they might well ſuppoſe they could ſay whatever they pleaſed with Impunity. Theſe are ſuch important Reaſons that will ever prevent them from carrying on any Controverſy in their Review; and they are accordingly found as if proceeding on ſuch mean Principles; and at the ſame Time, affirming for Truth the moſt notorious Falſhoods, as will evidently appear, when I come to their Animadverſions on my Philoſophical Eſſays.

(*a*) Here it plainly appears, that my Obſervations at that Time had not furniſhed me with Data ſufficient to enable me to account for that Force, which is now plainly deducible from the Doctrine of Falling Bodies, namely, *an exterior and univerſal* IMPELLING *Force.*

Problems can be ſatisfactorily ſolved, we may hope in Time, by means of ſuch a Correſpondence, to arrive at ſo much Perfection, as to attempt a true Theory, or regular Syſtem of that myſterious Science, and to ſee Electricity eſtabliſhed on as firm a Foundation as any other Science can claim."

ANIMADVERSIONS *of the* Monthly Reviewers *on that* Printed Letter: *See the* Appendix *to their* 26th Vol. p. 502.

Review. "We little thought," ſay thoſe *Reviewers*, "to have heard from Mr. *Lovett* 'again on this Subject, after what paſſed between us in a former Review; much leſs 'that he ſhould complain of our Severity, 'when he was himſelf, in ſo great a Degree, 'the Aggreſſor."

A. What a bare-faced Falſhood do they begin with; when they charge me with being the Aggreſſor? And the Reaſon that they give for it is as uncommon, *viz.* "That there are *Men* 'as well as *Arguments* that are unanſwerable; 'and it plainly appears to them that I deſerve 'a Place among the former."

B. There are but few who will ſuppoſe that you were the Aggreſſor, unleſs they had ſhewn wherein. What did you ſay in your Letter that they could conſtrue ſo as to make you the Aggreſſor?

A. I can think of nothing, except "*ſhoot-*" *ing the Truth*" was the great Crime. The Ears of ſome are indeed much too tender to hear the Voice of Truth when it is pointed towards them.

Review. " Bad Caſuiſt as he is, he is a bold ' Combatant(*a*); for tho' reduced to his ſtumps ' he is determined not to give out.—It is very ' juſtly remarked," ſay they, " by a judicious ' French Writer — " Tous ceux qui ſont ca-" pable de faire des Objections, ne ſont pas " toujours en Etat de comprendre tous les " Principes, dont depend la Reſolution de leur " Objections."——This ſeems to be the Caſe ' with Mr. *Lovett.*—Indeed he frankly con-' feſſes, that our Diſtinctions are too refined for ' the Comprehenſions of *Electricians*, and ſtiles ' ſuch reaſoning, in the uſual Cant of Igno-' rance and Incapacity, the Cobwebs of Meta-' phyſics. It does not however become a *mere* ' *Experiment-monger* to talk ſo diſreſpectfully of ' any Science (*b*); yet this our doughty Oppo-

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(*a*) Methinks I ſhould be glad to be informed what Affinity a *Caſuiſt*, i. e. one ſkilled in reſolving Caſes of Conſcience, bears to a *Combatant* in any Reſpect more than that they both begin with the ſame Letter

(*b*) This is ſuch a groſs and ungenerous Miſrepreſentation, that to ſet it in a true Light, and at the ſame Time to render it intelligible, it ſeems neceſſary to relate the whole Affair to you.

In the above-mentioned Letter, p. 6, Section 9, theſe Writers being found reaſoning moſt inconſiſtently concerning *electric Matter* and *electric Force*, they are reprehended in the following Manner by Way of Note on that 9th Section.—" That Water is a Conductor " of the *electric Force*, but not of the *electric Matter*; that by every

‘ nent is very earneſt with us to continue the
‘ Controverſy in our Review.”

Anſwer. “ Theſe Writers ſeemed not aware
‘ how greatly they humoured my Vanity when
‘ they ſtiled me an *Experiment-monger*; *a mere*
‘ *Experiment-monger*; which they intended as
‘ a Term of Reproach; whereas, it was at the
‘ ſame time ranking me with three of the
‘ greateſt Geniuſes that perhaps ever lived.
‘ The renowned Lord *Verulam*, the hon. and
‘ indefatigable Mr. *Boyle*, and the great Sir
‘ *Iſaac Newton*, who according to the Reviewers
‘ way of reaſoning and judging were
‘ ſome of the greateſt and mereſt *Experiment-mongers*
‘ that ever exiſted.”

Review. “ But, ſuppoſing it conſiſtent with
‘ our Plan, as it is not; to what purpoſe ſhould
‘ we diſpute? If Mr. *Lovet* cannot comprehend
‘ us, we never can hope to convince him: and
‘ as to his ſtrong deſire of entering into a nearer
‘ and cloſer Engagement, that the Matter in de-

“ Conductor of Electricity in theſe Experiments, a *Motion* only is
“ *propagated*, but no real Fire conveyed, tho' Sparks of Fire can
“ be diſcharged from any Point of that Conductor; theſe are Diſtinctions
“ too refined for the Comprehenſion of Electricians. You
“ cannot even ſuppoſe that a Mind ſeriouſly inquiſitive after
“ Truth, can be ſatisfied with ſuch *Cobwebs* of *Metaphyſics*. Surely,
“ it is more philoſophical, as well as more eaſy and natural, when
“ we *ſee* Fire copiouſly ſtreaming from the Extremities of electrified
“ Wires ranged near together, to truſt to our Senſes, and
“ to admit this as *occular Demonſtration* of the extreme Subtilty
“ of electric Fire, and of its Power to paſs through denſeſt
“ Bodies. To talk of *electric Force*, abſtractedly from *electric*
“ *Matter*, is abſolutely unintelligible.”

‘ bate may be brought to a fair Iſſue, and the Public no longer to remain in doubt which of us is in the right, we are willing to reſt our Cauſe with the judicious Reader on the merits of what has been already ſaid. Indeed we conceive, that thoſe who have paid any Attention to this little debate remain in no doubt about the matter: At leaſt, we ſhall think ſo till it is intimated to us from ſome other quarter: In which Caſe, when called upon by a Perſon capable of comprehending us and receiving Satisfaction on the Subject in Queſtion, we ſhall be ready to give it in as ample a Manner as is conſiſtent with our Work, or can be reaſonably required by our Readers.”

“ Our Antagoniſt will doubtleſs call this, in his uſual Stile, a Jeſuiſtical Way of ſhifting off the Argument; intollerable Arrogance; *&c.* we muſt take the Liberty to tell him, however, it is not the Argument, but *the Writer we ſhould be pleaſed to get rid of* (*a*): If we muſt engage in a Controverſy, we are indeed ſo far ambitious, as to wiſh it may be with a Writer capable of underſtanding, and replying to an Argument.”

Anſwer. May not this be properly be ſtiled Shuffling and Jeſuiſtical Evaſion; and ſuch as

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(*a*) Had there been any Truth in that Aſſertion, why did they ſeven Years after, *unprovoked*, attack me again? ——The Truth appears plainly to be this, though they are aſhamed to confeſs it, that they were in Reality weary of the Argument, and, conſcious that they were *unequal* to it, would fain ſhift it off to the Writer.

I obſerved candid Writers would be aſhamed of.

Five Years after, in the Year 1766, I publiſhed my Philoſophical Eſſays, which Performance was taken Notice of the ſame Year by the candid Authors of the Critical Review, who gave it ſo great a Character, that my cavilling *Hypercritics* had not the Face to vent their Spleen on it till full two Years after; when they might very probably think the commendatory Character given of it by the former was forgotten. I ſhall therefore next inform you, that after having viewed and reviewed the Contents of my Philoſophical Eſſays, *i. e.* having often peruſed them with the greateſt Care and Circumſpection which my ſlender Capacity would admit of, and conſcious that I had advanced nothing but what appeared to be ſtrictly agreeable to Truth; yet leſt I ſhould have been too much prejudiced in Favour of my own Sentiments, which was very probable as well as natural, I made it my Buſineſs to conſult not only my Friends with whom I converſed, but wrote to divers others to deſire they would favour me with what appeared to them to be not well founded, and would therefore be the moſt liable to Objection: My Intention in this was, that I might endeavour to obviate ſuch Objections for the future; by, firſt, ſtating them in their full Force, and then replying to them.— Theſe Thoughts naturally directed me to my old Antagoniſts, the *celebrated* Authors of the

Monthly Review, where I had no Doubt of being plentifully ſtocked without any more Trouble, but found myſelf greatly miſtaken; for inſtead of rational Objections, and ſuch as might be ſatisfactorily replied to, they were found inſulting their poor Culprit in the moſt ſcandalous Manner; and their Animadverſions ſuch as were quite incapable of any regular Anſwer, by being ſo ſtuffed with Bombaſt, immoderate Scoffing and Rancour, pointed with the keeneſt Sarcaſms and Scurrility, on the one hand, and as ridiculouſly ludicrous on the other.

In ſhort, nothing was omitted which they thought capable of rendering me contemptible; and they ſeemed at the ſame Time ſo vain as to think their Readers would be highly pleaſed with ſuch low Witticiſms and Froth (*a*). But altho' their Animadverſions were unworthy and even incapable of a regular Anſwer, yet that you may be able to form a Judgment of them, and their Manner of writing, I ſhall give you

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(*a*) I had a ſlight View of their Animadverſions ſoon after they were publiſhed, where I found nothing but what I expected, viz. ſuch Rant as above mentioned: As I had then no Intention of publiſhing a Supplement to my Eſſays, I had therefore no Deſign of troubling myſelf with them any more; but when I began *that*, I was inclined to peruſe their Remarks again with ſome Attention; but eſpecially when I found them to contain no leſs than ten Pages and an Half, it was no wonder if they excited my Curioſity ſo far as to examine how it was poſſible to ſpin them out to ſuch a *reſpectful* Extent, and what could induce ſuch eminent Writers to beſtow ſo much Time and Pains upon the trifling Labours of a Perſon whom they ſo frequently ſtile a moſt feeble Antagoniſt.

another curious and elaborate Specimen of both, which, if I miſtake not, you will think an Original.

Thoſe Reviewers, in their Animadverſions, accuſe me of producing or coining the Term *Tranſpeciation.*——" While we thought," ſay they, " that we were exerciſing Forbearance ' towards Mr. *Lovett*; behold! at page 391, ' [rather at p. 393] our own critical Sagacity at ' fault (*a*)! At the Sight of the Word *Tranſpeciation* ' which there occurs, we own we ' were ſufficiently diſconcerted We called ' forth all our philological Powers, and even ' ſummoned a Board of Criticiſm on the Oc- ' caſion, which broke up *re infectâ*, after con- ' ſulting every lexiphanic Book in *Becket*'s ' Shop, from Hedericus and Johnſon, even ' down to the Scoundrels' Dictionary. [Moſt ' wonderful!] We are candid enough to own, ' that tho' we at laſt maſtered it, it was not ' till our Index-maker, who was in waiting ' upon this Occaſion, inſtinctively, as it were, ' ſpied it in the Gloſſary or Explanation of the ' moſt difficult Words, which Mr. *Lovett*, we ' ſuſpect, from an old Grudge, and with a view ' of diſtreſſing us Critics, had artfully concealed ' behind his Index; [ſhrewdly gueſſed indeed!] ' we forgive him, however, and even congra- ' tulate him upon the prodigious Advances he ' has made in Literature, ſince the Publication

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(*a*) Wonderful indeed, that *that* ſhould ever be at a fault!

‘ of the Second Part of his Subtile Medium proved: At that Time he durſt not uſe the Term Electrician, without referring us in a Note to the Authority of Dr. *Franklin*; we find him now ſetting up for himſelf, and *producing*, if not *coining* a Word that has puzzled a whole College of Reviewers. We are prompted however, perhaps, by a little Spice of Envy, [ſhrewdly gueſſed again] to declare our Opinion, that the Word has too ill-favoured an Appearance, and is too ſtrangely turned ever to be admitted, without a Struggle, into the Engliſh Language.”

Query. Can this Harangue come from Philoſophers? Can ſuch Stuff be the Language of Critics? Have they not arrogantly uſurped the Title, and *ſet themſelves up* as Judges of the Labours of the Learned, and Cenſors in the Republic of Letters, before they were properly qualified for it? Can learned and ſagacious Men, ſuch as Critics are expected to be, be ignorant of the Meaning of ſuch a Term as *Tranſpeciation*? A Term ſo expreſſive, and which carries its meaning along with its ſound, as all Terms ought to do, and particularly technical ones. Could it be expected that a whole Body of Critics, or indeed any learned Men (not to ſay Body of Men) ſhould be ſo diſtreſſed as to ſummon their whole *College* to the *Council Board* about the Meaning of a *common* Word? At leaſt I had no Reaſon to think but it was as common and proper as moſt other Terms; particularly as I found it in a Dictionary, which has long had the Approbation of the Learned (*a*).

It is plain however from their own Account, that they were at no ſmall Pains about finding out the Meaning of that Word, and tell us they had not maſtered it at laſt, had it not been for their *Index-maker*, who, as they inform us, was in waiting on that *grand* Occaſion. This however is thought abundantly ſufficient to ſhew what trifling Writers they are, as well as implacable; implacable I ſay, ſince it was ſeven Years after they had heard from me, which was in my printed Letter to them, publiſhed in the Year 1761.—As I did not deſign to have any thing more to ſay to them, I never ſo much as mentioned them in my Eſſays.

Is it not ſtrange, that Critics, who avow themſelves to be Profeſſors of Science, and Adepts in Languages, ſhould be ſo miſerably at a Loſs for the Meaning of ſo ſignificant and intelligible a Term! A Word for which a Boy in the loweſt Claſs in a Grammar-ſchool would expoſe his Poſteriors to the ignominious Puniſhment of a whipping if he were ignorant

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(*a*) Bailey's Engliſh Dictionary, Edit. 3d.—I mentioned this Affair to one who ſhewed me the ſame Word in an Engliſh Dictionary of Cole's and doubtleſs it may be found in many others.—Why a Word, which is ſo expreſſive of its Meaning as this is, ſhould give Offence, the Author would be glad to be informed?—But, ſuppoſing it had not been ſo, has not every Writer the Liberty of chooſing his own Terms, provided he, like the Author, explains them?

of it; and if he were not capable of informing them that *Tranſpeciation* was a compound term, conſiſting of the Prepoſition *Trans*, and the Noun *Species:* For the Truth of the former, let them conſult their Accidence, and for the Senſe of the latter, I may refer them to every Latin Dictionary whatſoever. Let them bluſh then, if they know how, at being thus diſtreſſed by a Word which has puzzled their whole *College*, as they ſtile themſelves; and let me ſubjoin their merited Addition of B—h—ds: For who but ſuch would not have underſtood, at firſt Sight, a Term ſo eaſy and expreſſive as *Tranſpeciation*?

B. Thoſe Reviewers will ſurely be greatly irritated at you treating them with ſo little Ceremony.

A. What Right they can claim to any Favour from me, let the ſenſible and candid Reader judge, when he finds how rudely they have behaved towards me, tho' unprovoked.—As a Specimen of their ſcurrilous Treatment, let him obſerve the following Extract—

"Mr. *Lovett* indeed does not ſeem to know
'where the Difficulties attending the Subject
'really lie, tho' they are certainly obvious and
'numerous enough in all Conſcience. We re-
'commend it therefore to him to give Dr.
'*Franklin*'s Letters a careful Peruſal; and
'when he has maſtered them; to read Dr.
'*Prieſtley*'s familiar Introduction to the Study
'of Electricity, juſt publiſhed. It may ſeem

hard and unprecedented to turn a Founder of Syſtems down to the lower Forms in the School of Electricity; but when Mr. *Lovett* underſtands either of theſe Performances, he will own the Juſtice of this Degradation.— See Review, p. 377.

This, it is preſumed, is ſufficient to make it almoſt a Doubt whether they are entitled to ſo much as common Civility, were not that a Debt which we owe to all Men, even to the moſt abuſive and depraved.——

Thoſe Reviewers repreſent me as extravagantly vain, particulary in claiming Diſcoveries made in Electricity; and this Accuſation runs thro' no ſmall Part of their Animadverſions.

At p. 374. " Thoſe (ſay they) who have read his Eſſays on philoſophical Subjects, or our Accounts of them, may poſſibly recollect that the principal Purport of them is to prove that the *Spiritus Subtiliſſimus*, which Sir *Iſaac Newton* ſuppoſes to be a principal Agent in many of the capital Phenomena of the Univerſe, is now realized, and is no more than the electrical Fluid.—This Doctrine Mr. *Lovett* would have us look upon as a Diſcovery of his own, though he cannot be ignorant that there are numerous Fellow-claimants."

Anſwer. The former Part of this is true; but that I claim the Honour of being the firſt Diſcoverer of it is abſolutely falſe.——As for the ſubtile Medium of Sir *Iſaac Newton*, or the elementary Fire of the Antients, ſince in their Time neither of them could be proved by Experiment, or that any ſuch Thing exiſted, all therefore that they affirmed of it could be no more than Hypotheſis or mere Conjecture, it being only what they concluded from ſome of its remote Effects. As therefore Electricity has diſcovered, not only that ſuch a ſubtile Medium exiſts, as they had foretold, but alſo that it is found to be poſſeſſed of all the ſurpriſing Properties that had been aſcribed to it; and that ſo plainly as to be realized to the Senſes; was it not natural for me to think, ſince this is ſo obvious, that all who were converſant with electrical Experiments ſhould be convinced of the Similarity, or rather ſameneſs of them, as well as myſelf? I may ſafely appeal to all candid Enquirers, whether it was at all probable that I ſhould ſuppoſe myſelf the only one who could diſcover ſo clear a Truth. All who have read my Accounts of it, may find that theſe Writers have either not peruſed them with due Attention, or elſe have deſignedly miſrepreſented them; ſince I have been ſo far from endeavouring to perſuade the World that I was the only one who had made the firſt Diſcovery, that on the contrary I totally diſclaimed every Pretence of that kind, and think myſelf happy that Dr. *Hoadly* and Mr. *Wilſon* coincided with me in the ſame Sentiments.

At p. 375, they ſay, " Mr. *Lovett* not only ' ſuppoſes that the Air extricated from Water 'by the Action of the Air-pump is real Æther, 'but even that the Bubbles which ariſe from 'the Surface of a Piece of Braſs immerſed in it, 'are Particles of Æther coming out from the 'Subſtance of the Metal. The pure electrical 'Air (ſays he) contained in it [the Braſs] ſoon 'begins to ſhew itſelf, and if the Operation '[of Exhauſtion] continues, almoſt the whole 'Surface of the Braſs will be covered with 'little pearly Bubbles which riſe out of it; 'conſequently the Braſs is pervious by this 'pure Air, *i. e.* the Æther."

Anſwer. Is it not natural to conclude ſo, for the ſame Reaſons there given? *viz.* that tho' the Braſs is pervious by this pure Air or Æther, it is far from being ſo by the common Air. So far from it, that even the Barrels of the common condenſing Engines are generally made of Braſs to confine the Air, altho' it be ſometimes extremely condenſed withinſide of it.——It is the ſame in the Chamber of an Air-gun, which is alſo made of Braſs, and is no more than a different condenſing Engine.

If in the foregoing Experiment it had been common Air, and yet found ſo eaſy an Eſcape out of the Piece of Braſs in the Water, when only the Spring of the common Atmoſphere was taken off; how much eaſier would it pervade the Braſs Barrel of the Condenſer, or of the Air-gun, when the Elaſticity was then, perhaps, ten Times, or much more, increaſed?

Notwithſtanding, that ſo long ago as I wrote my Second Part of THE SUBTILE MEDIUM PROVED, in Vindication of the Firſt Part, which was publiſhed in the Year 1756; at which Time I was very aſſiduous in my Endeavours to proclaim to the World, that I was *not* the only Perſon who was of the Opinion, that the electrical Fluid and Sir *Iſaac Newton*'s Æther were identically the ſame ſubtile Fluid, yet theſe Reviewers had the Front, eleven or twelve Years after, *viz.* in the Year 1768, to *charge* me with claiming the Diſcovery as my own (*a*). To prove that this is a *falſe Charge*, obſerve the following Tranſcript from the Second Part of my Subtile Medium proved, entitled, Sir *Iſaac Newton*'s Æther realized, p. 34.

1768

" That the electrical Fluid is the very Æther, ' it is preſumed is what is now queſtioned by ' few Philoſophers; altho', when I wrote that ' Pamphlet, it did not ſeem to be generally ' allowed; and to ſay the Truth, I was for that ' Reaſon under ſome Apprehenſion of being ' publickly chaſtiſed (if thought worthy of ' Notice) for affirming it ſo peremptorily; ' becauſe I was ſo audacious as to be the firſt ' who had ventured to ſpeak his Mind on that ' Head ſo freely; at leaſt, that ever I knew of, ' although ſeveral had *hinted* the ſame Thing ' before, particularly, the forementioned inge' nious Mr. *Wilſon*, in a former Treatiſe on the

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(*a*) Monthly Review, 1768, p 374.

‘ Electrical Fluid; who ſhewed it ſo plainly to ‘ be his real Opinion, and his Arguments ‘ ſeemed ſo convincing, that I could not help ‘ admiring his Opinion was not more generally ‘ received, notwithſtanding the great Modeſty ‘ with which he delivered his Sentiments.— ‘ Others ſtill more cautious, only affirming the ‘ Æther to be the *Cauſe* of the electrical Phenomenon. For theſe and ſuch like Reaſons, ‘ I was determined, at all Events, to venture to ‘ ſpeak my Mind without any Reſerve, eſpecially, as I was ſure I could confirm my Arguments by the moſt convincing Experiments.”

But contrary to my Expectation, no one that I ever heard of, condemned me for it. And to my ſtill greater Satisfaction; about the ſame Time my Pamphlet was publiſhed, came out thoſe Obſervations of Dr. *Hoadly*, in Conjunction with the above-mentioned Mr. *Wilſon*, wherein they had expreſſed their Sentiments more fully than I had ever ſeen in any Author before; affirming it to be unphiloſophical to ſuppoſe, that the Æther of Sir *Iſaac Newton* and the electrical Fluid were two diſtinct Fluids. It is true they ſoftened the Expreſſion, by ſaying, it was much more philoſophical to ſuppoſe them one and the ſame Fluid, than to ſuppoſe them two.

The Manner in which they expreſs themſelves is as follows:

“ Thus have we gone thro’ the moſt intereſting of the electrical Experiments, and from

‘ the various appearances they afford, it appears
‘ that the electrical Fluid is as univerſal and
‘ powerful an Agent, at, or near the Surface
‘ of the Earth, as that Fluid which Sir *Iſaac*
‘ *Newton*, in his Optics, calls Æther; that it
‘ is as ſubtile and elaſtic in its Nature as Æther
‘ is; and as Æther does, that it pervades the
‘ Pores of all Bodies whatever that we are con-
‘ verſant with; is diſperſed through whatever
‘ Vacuum it is in our Power to produce by
‘ Art; and from the natural Phenomena of
‘ Thunder, Lightning, *&c.* ſeems to be ex-
‘ tended to very great Diſtances in the Air.”

“ We ſhall make no Scruple therefore now
‘ to affirm, that theſe two Fluids are one
‘ and the ſame Fluid; and *it is much more phi-*
‘ *loſophical to do ſo*, than to ſuppoſe two ſuch
‘ Fluids, each of them equally capable of pro-
‘ ducing thoſe Effects, and equally preſent
‘ every where, which would be multiplying
‘ Cauſes where there is no manner of Occa-
‘ ſion (*a*).” See Dr. *Hoadly*’s and Mr. *Wilſon*’s Obſervations on a Series of electrical Experiments, p. 68; or my Eſſays, Part II. p. 182.

(*a*) The Partiality of theſe Reviewers is remarkably notorious. —Dr Hoadly’s and Mr. Wilſon’s Series of Electrical Experiments, and my Pamphlet, entitled, The Subtile Medium proved, were both of them publiſhed in the Year 1756.—Mine they condemned, for endeavouring to prove, that the electrical Fluid was the identical Æther of Sir Iſaac Newton: Dr. Hoadly’s and Mr. Wilſon’s Series, which endeavoured to prove the ſame thing, was applauded by them, who declared it to be their Opinion, that the Doctor and Mr. Wilſon had rendered it very probable.

B. You have frequently hinted that the Animadverſions of thoſe Writers were of ſuch a Nature as rendered them incapable of a regular Anſwer; I wiſh therefore you would give me a Specimen of the Method they make Uſe of.

A. There is no arguing with Men who are determined to turn every thing into Banter and Ridicule, which is their conſtant Method, and particularly, when they come to an Argument that is likely to pinch them. Where they happen to be capable of ſuch an Anſwer, there are ſo many ignorant and inſolent Cavils, as render them unworthy of it.

B. Your Aſſertions concerning them are too general; I deſire a Specimen of thoſe Particulars, which are of ſuch a Nature as render them *incapable* of an Anſwer.

A. I have no need at preſent to inſtance in more than one of them, which alone you will think ſufficient.—I had affirmed that the Experiment made with the Leyden Phial had diſcovered ſuch an Opening with regard to Electricity, that it might not improperly be called a Key. A Key, which, if properly applied, would be found capable of unlocking many of the Secrets of Nature; or to that effect. But this *ſerious* Expreſſion was turned into ſo great a Jeſt as not eaſily to be equalled. In the firſt Place, they repreſent me, as endeavouring to ſhew, that Profeſſor *Muſchenbroek* was only the Organ or Inſtrument employed by Heaven (unknown to himſelf) to deliver the Leyden

Phial, with the Key annexed to it, into my Hands.—" Then (ſay they) let us ſee how he
' employs this ſame Key on the Leyden Phial
' itſelf.—Heaven grant he be not a Bungler."

" Chap. XI. and XII. Nothing done!—Mr.
' *Lovett's* is not the true ſuper-celeſtial Key,
' but a Counterfeit, forged at *Worceſter*.—We
' have attended on him this Half-hour, fumbling and endeavouring to turn it this Way
' and that Way to no Purpoſe. The Leyden
' Phial is juſt where it was, and as cloſe locked
' up as ever. — But ſtop—ſee he takes up the
' excellent Paſſe par-tout of Dr. *Franklin*.
' This will do the Buſineſs, if he has but the
' Addreſs to uſe it properly. S'death, he turns
' it the wrong Way, *&c*." Review, p. 377.

Is not this Specimen ſufficient to ſhew that they endeavour to write in ſuch a Manner as to be incapable of a ſerious Anſwer?

But were it worth while, I might inſtance in many others, wherein by means of *Inconſiſtencies* and *Sophiſtry*, they are rendered as incapable of an Anſwer, as in the former. I ſhall inſtance in one of their Harangues in a former Diſpute.
—" We would not, however, (ſay they) be too
' ſevere on a Writer who confeſſes his Want of
' literary Accompliſhments, and appears to be
' a well-meaning and ingenuous Enquirer; but
' to oblige him, ſhall condeſcend to correct
' ſome of his Errors in a candid and good-natured Manner. One great Miſtake of which
' Mr. *Lovett* is guilty, particularly, indeed,
' concerns

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'concerns ourſelves. As we inferred, from his 'apparent ignorance of the Newtonian Philo-'ſophy, that he was not the moſt fit Perſon to 'explain the Phenomena of Electricity; he 'ſuppoſes therefore, that we are alſo of Opinion 'that thoſe Phenomena *are* explicable by New-'tonian Principles. But this does not follow (*a*). 'All the Words that may be formed from the 'ſeveral Combinations of the Letters in our 'Alphabet, are not intelligible to us merely 'from our Knowledge of the Power and Uſe of 'each of thoſe Letters; and yet without a pre-'vious acquaintance with the Alphabet, words 'in general will not be at all intelligible. The 'Principles of Sir *Iſaac Newton* form the Al-'phabet of Nature's Language (*b*); and tho' 'even the moſt perfect Knowledge of them 'doth not enable us to read at once the various 'Theorems written in the Volume of the Uni-'verſe; yet without our being initiated into 'phyſiological Myſteries, by an Acquaintance 'with thoſe elementary Characters, we can 'hardly proceed one Step without blunder-'ing (*c*).

They next proceed in their begging way, and take for granted their Principle of *Attraction*, and that of the *Vis inertiæ*, in the following Words.

(*a*) To reconcile this Inconſiſtency, they are conſtrained to have Recourſe to their ſophiſtical Manner of arguing.

(*b*) But this is begging the Queſtion, and taking for granted the very thing that they are expected to prove.

(*c*) This is ſtill begging the Queſtion.

"True indeed it is, that from the Principle ' of univerſal Attraction, and the mechanical ' Action of inert Bodies, we can in no ſatisfac' tory manner account, even for the common ' Coheſion between the Parts of ſolid Bodies, ' and their various and moſt palpable Modes of ' Reſiſtance. The Reality of ſuch a Principle ' of Attraction, however, and the *Vis inertiæ* ' of Bodies is, nevertheleſs, indiſputable; and ' the Laws of Mechaniſm are no leſs juſt; ſo ' that whoever would proceed in phyſiological ' Enquiries with any well grounded Hope of ' Succeſs, muſt build on Newtonian Principles: ' for though all Phenomena are not explicable ' thereby, yet it is to theſe Principles we muſt ' occaſionally recur, to know whether natural ' Appearances are juſtly explained or not (*a*)." Review, 1759, page 300.

A. It may be neceſſary now to inform you, that there is no other effectual Way of dealing with theſe Friblers, theſe Pretenders to Criticiſm, with Succeſs, than by firſt diveſting them of their *Palladium, i. e.* their offenſive and defenſive Weapon, *Ridicule*; for by means of ſo powerful and univerſal an Auxiliary, they can elude the Force of the ſtrongeſt Arguments without any kind of Trouble, on any Subject that appears to them too formidable to be diſ-

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(*a*) Here I might remark as formerly, the great Pains they took to ſhew, if they could, that true Philoſophy was to be learned from Sir Iſaac Newton's Principles, but not to be explained by them.

cuſſed in a fair and candid Manner. I ſhall give you an Inſtance or two, which will be abundantly ſufficient to confirm my Aſſertion beyond Diſpute.

My Theory of the Nature and Office of the Sun has been much applauded, not only as it appears highly reaſonable, but as it affords Data ſufficient to account for even *Gravity* itſelf, or that centripetal *Force* and Tendency of the Heavenly Bodies towards the *Sun*, which before had been given up as inexplicable; and for that Reaſon too deep for the ſhallow Reviewers to fathom.

But by their evaſive Method, they never fail to ſhift off the trouble of diſcuſſing any Subject which they do not underſtand, as will appear from the following Quotation, p. 380.—

" In the 5th Chap. of this Part, our Author ' (ſay they) ſoars into the extra-mundane ' Space, and aſſigns to the Sun and fixt Stars ' the Office of diſpenſing this ſubtile Fluid, ' under the Title of Circulators.—But here we ' muſt leave Mr. *Lovett* to himſelf. We ſhould ' only prove a dead Weight to him in his Aſ' cent. In good truth, we are afraid to follow ' this philoſophical *Icarus* ſo very high. We ' are very ready to attend him at the electric ' Wheel, or as far as to the Blackſmith's Shop, ' or even to mount up with him as high as a ' Thunder-cloud; but not one of our Body, ' Dare-devils as he may think us, to whom this ' deſperate ſervice was propoſed, could be found 'daring enough to truſt himſelf under Mr. *Lovett*'s Guidance, up to thoſe giddy Heights in 'the wide extended Empyrœum to which he 'here beckons us.—Mr. *Lovett* will, we know, 'pity our weak Heads (*a*): But really the ſight 'of his Plate, repreſenting numerous Suns and 'Stars darting forth and circulating his æthe'real Fluid, gave us all a Vertigo."

One of the greateſt Improprieties that they charge me with, is my Propenſity to quoting: And ſo extravagantly fond are they of proclaiming this on all Occaſions, as even to defeat their own Intentions, by proving the Truth of the very Thing they would deny.—A remarkable Paſſage of this kind may be found in their Review, at p. 381, where they ſay, —" Mr. '*Lovett* has indeed two Propenſities which, 'ſomewhat unluckily for his Fame, very much 'interfere with each other; a Fondneſs for 'making Diſcoveries, and a ſtrong Paſſion for 'Quoting: The untoward Conſequence at'tending theſe two Propenſities is, that he 'generally conveys to us his Diſcoveries and 'Obſervations in the Words of preceding 'Writers."

Anſwer. Is this claiming the Diſcoveries as my own? Can any one forbear laughing at the Inconſiſtencies of theſe Writers? For can there be any more effectual Way of *diſclaiming*

(*a*) Indeed I do heartily pity, as they propheſied I ſhould, their weak Heads; though at the ſame Time I publickly and ſincerely deteſt their perfidious Hearts.

them, than to convey ſuch Diſcoveries to others in the Words of the Diſcoverers themſelves (*a*).

They alſo charge me with Quoting from my own ſelf: But who elſe can I quote from; ſince no one beſides me has treated the ſame Subject in the ſame Way?

Is ſuch Diſingenuity conſiſtent with that Candour and Veracity which the Public have an undoubted Right to expect from *Perſons* who preſume to place *themſelves* on the Bench of literary Juſtice, and arbitrarily dictate to the World a definitive Judgment upon ſo curious a Subject, which they have only ſuperficially conſidered (*b*)? Whereas the Author hath made the ſame Subject the particular Object of his Study, at his leiſure Hours, for no ſmall Part of his Life.

That Men of their pretended Rank ſhould ſo riſk their Reputation to ſerve no other Purpoſe

than

(*a*) To ſay the Truth, I have two cogent Reaſons to urge in Defence of my Quoting: Firſt, I ſeldom could think ſo well of my own Method or Style of Writing, as of that of moſt other Authors: And, ſecondly, for the ſame Reaſon, it was my common Method to publiſh the Diſcoveries and Obſervations of others in their own Words.

(*b*) That this is notorious, ſee their Animadverſions on my Reviewers Reviewed, or the Concluſion of my printed Letter to them. —Their own Words are the following, "*We ſhall leave the Illuſtration of this intricate Subject, to ſuch as may make it the particular Object of their Study*."

Here the Inconſiſtency of thoſe celebrated Writers is highly worthy of Remark, who, tho' they tacitly confeſs that they have not made Electricity a principal Object of their Study, ſhould yet, at the ſame time, take upon them to correct thoſe who *have*. This is Modeſty indeed, and ſhews their *polite* Taſte for Criticiſm!

than the mere gratifying of an implacable Temper!—It could hardly have been credited, that ever the Authors of the Monthly Review would have acted ſo mean a Part, to ſerve ſo baſe an End, had it not been plainly and undeniably proved againſt them.

They next publickly arraign me as being ridiculouſly vain-glorious, and laying claim to moſt of the Diſcoveries that have been made in Electricity, or at leaſt to thoſe that are mentioned in the Eſſays: Whereas the Reader will find the Reverſe of that Character to be due to me. I have been always exceedingly cautious and careful when writing, that nothing dropped from my Pen which could be conſtrued like claiming *any* Diſcovery; particularly, thoſe to which I had no right.

As thoſe implacable Writers, thoſe falſe Accuſers, have taken great Pains to render me a moſt ridiculous and vain-glorious Author, one who endeavoured to impoſe on the Public by groſs Miſrepreſentations, falſe Pretenſions, and downright Lyes; it is preſumed I ought, in Juſtice to the World as well as to myſelf, to ſay ſomewhat in Defence of my own Character, and to ſhow that I might with Truth have laid Claim to many Diſcoveries, tho' I did not: As, —Firſt, I might have affirmed, that I was the only one among either the Moderns or the Antients (beſides *Theophraſtus*) who diſcovered and maintained that Fire and Heat were two different and diſtinct Things. That the former was the Principle or *Cauſe*, and the latter was only an accidental Property of it: An Effect, generated by a mutual Attrition of the Particles of Fire among themſelves.——Secondly, I might with equal Truth have affirmed, that I was the firſt Diſcoverer of a Variety of other Things, as—That I was the firſt who had obſerved that the electrical Fluid was the true elementary and moſt pure Fire, equal in Purity to that of the ſolar Fire in the Focus of a Burning-glaſs, inſomuch as like that, to yield neither Smoke nor Aſhes.—Thirdly, That I was the only Perſon who had explained the convulſive Experiment; that is, the Effect produced at the diſcharging of the Leyden Phial; or that ever attempted to explain it from Principles previouſly proved. See Chap. XII. of the firſt Part of my Eſſays, or Dialogue VIII. of the preſent Performance. —Fourthly, That I had diſcovered a rational Method to account for many electrical Experiments in a more ſatisfactory Manner than was known before; particularly, the Detenſion of the electrical Fluid in the open Air, when accumulated on Bodies electriſed, notwithſtanding its extreme Elaſticity and ſurpriſing expanſive Force.——Fifthly, That no one beſides me ever diſcovered the great Neceſſity of conſidering the indefinite Elaſticity and Rarity of the ſubtile Medium, according to Sir *Iſaac Newton*'s Inveſtigation, and of its Exiſtence in the Pores and Vacuities of all groſs Bodies; a clear

Knowledge

Author's own Discoveries

Knowledge of which is ſo abſolutely neceſſary, that without it, as I have more than once before obſerved, it would be impoſſible to account for any of the electrical Experiments, ſo as to reconcile them with Obſervation, or with one another: Of this I am ſo very certain, from a ſtrict and repeated Examination of the Premiſes, that I can venture to affirm, that the Experiments are abſolutely inexplicable by any other Means.——Sixthly, That I had diſcovered the common Miſtakes concerning Magnets; that of their being poſſeſſed, like the Earth, of two Poles and an Axis. That I had detected the Miſtake by obſerving, if that were the Caſe, that a large one might be divided and ſubdivided, and yet each Part would be endued with two Poles and an Axis, as well as the whole before it was divided.——Seventhly, I might moreover have boaſted, that the Authors of the *Critical Review* had declared it their Opinion, that I had diſcovered the very Laws by which the Variation of the Mariner's Compaſs-needle is influenced.——Eighthly, And tho' the Monthly Reviewers affirmed, that they did not diſcern any one good Purpoſe in the *world* that could be ſerved by my Eſſays, yet the Authors of the *Critical Review* diſcovered ſo much in them that was uſeful and valuable, that they thought fit to recommend the Peruſal of them, as being *evidently a Work of Genius, and by no means undeſerving the Peruſal of modern Philoſophers.*——

Ninthly, In a Word, had I been ſo fond of claiming Diſcoveries, as I am repreſented to be, I ſhould doubtleſs have ſet up a Title to a Variety of other grand Diſcoveries; even a rational Method to account for the *Cauſe* of *Gravity* itſelf, as well as *Coheſion*; the Origin of *Motion*, *&c.* *&c.* ſince thoſe formidable Difficulties were never ſurmounted before in a natural Way.

The particular Diſcovery which they next charge me with claiming is, that of the Permanency of Fire; and as they ſeem juſtly enough to think that ſome Proof would be expected, they are accordingly, at page 379 of their Review for 1768, found drawing up their Charge in the following Manner.

"Our Author proceeds in his Second Part 'to treat of Fire, which he conſiders as an 'Element, or, as he chooſes to expreſs it, a 'created Entity, which, ſays he elſewhere, *I* '*have diſcovered to be permanent.*"

Anſwer. This laſt Aſſertion (viz. *I have diſcovered to be permanent)* is abſolutely falſe; and I defy them all to point out one ſingle Paſſage in any Part of my Eſſays, where I affirmed, that I had diſcovered Fire to be permanent.

Theſe Words are no where to be found, but in a *ſuppoſed* Declaration, which I imagined likely enough to have been made by Biſhop *Berkeley*, placed in that philoſophical Situation which you will find particularly deſcribed a few Pages on.

" *Indeed, ſo univerſal a Principle,* as Fire
' appears to be, could not fail of exhibiting at
' all Times its extenſive Properties; and there-
' fore, happily long ago, ſome Men purſued
' their Enquiries into the Eſſence of it, from
' its remote Effects. This appears to have been
' the caſe with reſpect to many of the Antients,
' who, without the Advantage of our modern
' Experiments on Fire, have given us a moſt
' accurate Account of it; an Account which
' correſponds and coincides with the Fire
' which we have diſcovered by means of Elec-
' tricity to a moſt ſurpriſing Exactneſs, as any
' one will ſee, when he compares their De-
' ſcription of it with our Diſcoveries."

The learned Biſhop of *Cloyne* judiciouſly adopted their Opinions, and collected many of them in his SIRIS; where he has alſo given us his own Sentiments on the Subject.

The following is a Tranſcript of Biſhop *Berkeley*'s Theory of Fire, which it will be neceſſary to inſert here, to elucidate the preſent Subject.

" The Order and Courſe of Things, and the
' Experiments we daily make," ſays that learn-
ed Prelate, " ſhews there is a Mind that go-
' verns and actuates this mundane Syſtem, as
' the proper real Agent and Cauſe. And that
' the inferior inſtrumental Cauſe is pure Æther,
' Fire, or the *Subſtance of Light*; which is ap-
' plied and determined by an infinite Mind, in
' the Macrocoſm or Univerſe, with unlimited

‘ Power, and according to ſtated Rules; as it ‘ is in the Microcoſm with limited Power and ‘ Skill by the human Mind.” Siris, ſect. 154.

“ The *Callidum innatum*, the vital Flame, or ‘ animal Spirit in Man, is the ſuppoſed Cauſe ‘ of all the Motions in the ſeveral Parts of his ‘ Body, whether voluntary or natural; that is, ‘ it is the Inſtrument by means whereof the ‘ Mind exerts and manifeſts herſelf in the ‘ Motions of the Body, *&c.*” Sect. 156.

“ This pure Spirit, or inviſible Fire, is ever ‘ ready to exert and ſhew itſelf in its Effects, ‘ cheriſhing, heating, fermenting, diſſolving, ‘ ſhining, and operating in various Manners, ‘ where a Subject offers, to employ or deter‘mine its Force. It is preſent in all Parts of ‘ the Earth and Firmament, though perhaps ‘ latent and unobſerved, till ſome Accident ‘ produceth it into Act, and renders it viſible ‘ in its Effects.” Sect. 157.

“ There is no Effect in Nature, great, mar‘vellous, or terrible, but proceeds from Fire; ‘ that diffuſed and active Principle, which at ‘ the ſame Time that it ſhakes the Earth and ‘ Heavens, will enter, divide, and diſſolve the ‘ ſmalleſt, cloſeſt, and moſt compact Bodies. ‘ In remote Cavities of the Earth it remains ‘ quiet, till perhaps an accidental Spark from ‘ the Colliſion of one Stone againſt another, ‘ kindles an Exhalation that gives Birth to an ‘ Earthquake, or Tempeſt, which ſplits Moun‘tains or overturns Cities. This ſame Fire

‘ ſtands unſeen in the Focus of a Burning-glaſs, ‘ till Subjects for it to act upon come in its ‘ Way, when it is found to melt, calcine, or ‘ vitrify the hardeſt Bodies.” Sect. 158.

“ No Eye could ever hitherto diſcern, and ‘ no Senſe perceive the animal Spirit in a human Body, otherwiſe than from its Effects. ‘ The ſame may be ſaid of pure Fire, or the ‘ Spirit of the Univerſe, which is perceived ‘ only by means of ſome other Bodies on ‘ which it operates, or with which it is joined.” Sect. 159.

“ In the human Body, the Mind orders and ‘ moves the Limbs: But the animal Spirit is ‘ ſuppoſed the immediate phyſical Cauſe of their ‘ Motion. So likewiſe in the mundane Syſtem, ‘ a Mind preſides; but the immediate, mechanical, or inſtrumental Cauſe, that moves, or ‘ animates all its Parts, is the pure elementary ‘ Fire, or Spirit of the World. The more fine ‘ and ſubtile Part or Spirit is ſuppoſed to receive the Impreſſions from the firſt Mover, ‘ and communicate them to the groſſer ſenſible ‘ Parts of this World.” Sect. 161.

“ The Abraſions of all terreſtrial Things being rendered volatile and elaſtic by Fire, and ‘ at the ſame Time leſſening the Volatility and ‘ expanſive Force of the Fire, whoſe Particles ‘ they attract and adhere to, there is produced ‘ a new Fluid, more volatile than Water and ‘ Earth, and more fixed than Fire. Therefore ‘ the Virtues and Operations imputed to Air, 'muſt be ultimately attributed to Fire, as that 'which imparts Activity to the Air itſelf." (*a*)

"The *Platoniſts* and *Pythagoreans* held Fire 'to be the immediate natural Agent, or animal 'Spirit, to cheriſh, to warm, to heat, to en'lighten, to vegetate, to perform the Digeſ'tions, Circulations, Secretions, and organical 'Motions in all living Bodies, vegetable or 'animal, being Effects of that Element, which 'as it actuates the Macrocoſm, ſo it animates 'the Microcoſm." Sect. 166.

"Æther, by the antient Philoſophers, was 'uſed to ſignify promiſcuouſly, ſometimes Fire 'and ſometimes Air. For they diſtinguiſhed 'two ſorts of Air. *Plato*, in the *Timæus*, 'ſpeaking of Air, ſaith, there are two Kinds, 'the one more fine and ſubtile, called Æther, 'the other more groſs and replete with Va'pours. This Æther or pure Medium, 'ſeems to have been the Air or Principle from 'which all Things, according to *Anaximenes*, 'derived their Birth, and into which they 'were back again reſolved at their Death. *Hy'pocrates*, in his Treatiſe *de Diæta*, ſpeaketh 'of a Fire pure and inviſible; and this, ac'cording to him, is that, which ſtirring and 'giving Movement to all Things, cauſes them 'to appear, or, as he ſtiles it, come into Evi'dence; that is, to exiſt every one in its Time, 'and according to its Deſtiny. Sect. 168.

"This

(*a*) See my 4th Fundamental Principle, Eſſays, p. 23.

“ This pure Fire, Æther, or Subſtance of
‘ Light, was accounted in itſelf inviſible and
‘ imperceptible to all our Senſes, being per-
‘ ceived only by its Effects.” Sect. 169.

“ Such is the rarifying and expanſive Force
‘ of this Element, as to produce in an Inſtant of
‘ time the greateſt and moſt ſtupendous effects;
‘ a ſufficient Proof not only of the Power of
‘ Fire, but alſo of the Wiſdom with which it
‘ is managed and with-held from burſting forth
‘ every Moment to the utter Ravage and De-
‘ ſtruction of all Things. And it is very re-
‘ markable that this ſame Element, ſo fierce
‘ and deſtructive, ſhould yet be ſo variouſly tem-
‘ pered and applied, as to be withal the ſalutary
‘ Warmth, the genial, cheriſhing, and vital
‘ Flame of all living Creatures.” Sect. 170.

“ Thus *Hypocrates*, in his Treatiſe *de Diæta*,
‘ ſpeaks of a ſtrong but inviſible Fire, that
‘ rules all Things without Noiſe. Herein, ſaith
‘ he, reſides Soul, Underſtanding, Prudence,
‘ Growth, Motion, Diminution, Change, Sleep,
‘ and Waking, This is what governs all
‘ Things, and is never in Repoſe.” Sect. 174.

“ *Theophraſtus*, in his Book *de Igne*, diſtin-
‘ guiſheth between Fire and Heat. The firſt
‘ he conſiders as a Principle or Cauſe, not that
‘ which appeareth to Senſe, as a Paſſion or Ac-
‘ cident, exiſting in a Subject, and which is in
‘ Truth the Effect of that unſeen Principle.
‘ And it is remarkable, that he refers the treat-
‘ ing of this inviſible Fire or Heat to the In-

'veſtigation of the firſt Cauſes. Fire, the 'principal, is neither generated nor deſtroyed, 'is every where and always preſent; while its 'Effects, in different Times and Places, ſhew 'themſelves more or leſs, and are very various; 'ſoft and cheriſhing, or violent and deſtructive; terrible or agreeable; conveying Good 'and Evil, Growth and Decay, Life and 'Death, throughout the mundane Syſtem." Sect. 176.

"In the *Aſclepian* Dialogue we find this 'Notion; that all Parts of the World vegetate 'by a fine ſubtile Æther, which acts as an Engine or Inſtrument, ſubject to the Will of the 'ſupreme God." Sect. 177.

"The Light, Fire, or celeſtial Æther, being 'parted by refracting or reflecting Bodies, produceth a Variety of Colours: Even ſo, that 'ſame apparently uniform Subſtance being 'parted and ſecreted by the attracting and repelling Powers of the divers ſecretory Ducts 'of Plants and Animals. that is, by natural 'Chemiſtry, produceth or imparteth the various ſpecific Properties of natural Bodies.— 'Whence the Taſtes and Odours, and medicinal Virtues ſo various in Vegetables."

Much more to the ſame effect is contained in his SIRIS, to ſtrengthen and confirm the Doctrine of an univerſal Æther or Fire: But it is preſumed, that what I have tranſcribed is amply ſufficient for a Specimen. Thoſe, therefore, who are converſant with that Theory, may eaſily turn over ſuch of the Sections which may be thought ſuperfluous; while others, perhaps, who never ſaw any of them, will not be offended at their Number.

When I conſidered how minutely Biſhop *Berkeley*'s Theory of elementary Fire agreed with what we have ſince diſcovered and reduced to Practice, I could not help reaſoning with myſelf in the following Manner.

[Had it been the *Biſhop*'s Lot, inſtead of Profeſſor *Muſchenbroek*'s, to have diſcovered the famous Experiment with the Phial, ſince called the Leyden Experiment: Had he been throughly acquainted with the ſubſequent Improvements which have been made in Electricity, and had concealed the Diſcovery of them till he publiſhed his SIRIS, inſtead of the Form in which it now appears, he would probably have concluded it after the following, or a ſimilar Manner.]

I am thoroughly convinced that had I publiſhed this Account of Æther or Fire, unſupported by Experiments, it would have been rejected as romantic; but I can with the greateſt Pleaſure and Truth inform my Readers, that I have happily diſcovered the very ethereal Medium, which I have here been treating of, and by means of a ſimple Machine, and very little Labour, am enabled to produce it; not from the Air encompaſſing the Machine, as might be ſuppoſed, but from the Earth, Water, Minerals, Animals, Vegetables, &c. And what will ſeem much more ſtrange, I can *not only demonſtrate it to be Fire, but can collect the ſame Fire from the Thunder-clouds* (a) *in great Abundance; and retain it even in ſuch Plenty, as when let looſe to produce loud Claps of Thunder* (b); *and what will undeniably prove it to be the very identical Fire I collect at my Machine, I can make the very ſame Experiments with it; ſo that I am thoroughly convinced, that this wonderful Agent muſt be univerſal, and that all Nature is replete with it. And notwithſtanding the extreme Elaſticity and Subtilty with which it is endued, I can collect and retain it in almoſt whatever Quantity I pleaſe, whereby all its moſt eſſential and accidental Properties may be eaſily diſcovered by proper Experiments.*

In a Word, this is the univerſal ſubtile Æther ſo much like Air, which according to Sir Iſaac Newton *is expanded throughout all the Heavens* (c), *and the ſame which he affirms to lie hidden in the Pores of all groſs Bodies* (d); *and this Æther is therefore the pure elementary Fire of the Antients, which I have diſcovered to be permanent.*

[Had the Subſtance of what is contained in the foregoing Sheets, been introduced with all the Additions and Graces with which ſo accompliſhed a Writer was capable of adorning the Subject, what a different Effect would it have had on the Minds of Men, who were all, till then, ignorant of the Exiſtence of any ſuch active mechanical Agent in Nature? What a general Reception would his Book have met with? Who, after that, would have doubted, whether the electrical Fluid, juſt then diſcovered, which was endued with the ſame Qualities that Sir *Iſaac Newton* had aſcribed to his ethereal Fluid, was the ſame Fluid or not; particularly, as it muſt have appeared to be actual Fire, inſomuch as not only to kindle up Combuſtibles into a real Flame, but to fuſe Metals in an Inſtant (*a*).]

(a) Dr. Franklin's Experiments.

(b) See Romas's Kite, Sect. 313, 314, Part I. of the Eſſays.

(c) Optics, Quære 18th.

(d) Principia, Lib. III. p. 393.

Thus have I, excluſive of my own Trouble, given the Reader that of this Recapitulation of that feigned Speech which I ſuppoſed might, without any Impropriety, have been made by Biſhop *Berkeley* at the Concluſion of his Theory on Fire; which, it was preſumed, I might do without giving Offence to any Reader: But it ſeems that theſe Scandal-hunters, having ſearched my whole Book, could find no Paſſage in it ſo proper to fix on, as a Baſis whereon to found their Aſſertion, as the ſix laſt Words of that feigned Speech, *viz.* "I have diſcovered to "be permanent." No one, however, thinks them ſo ſtupid, or ſo ſhort-ſighted, as not to ſee the plain Drift of that Expreſſion; and their uſhering it in with an *elſewhere*, was a Proof ſufficient to ſhow a conſcious Guilt of ſome-

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(*a*) As in Dr. Franklin's Experiments.

thing couched under it, which they were endeavouring to conceal.

May I not now juſtly appeal to the Public, whether ſuch a falſe and ſcandalous Way of proceeding be not playing a mean and low Game; ſince they could have no other Reaſon for it, than merely to gratify an implacable and perſecuting Temper (*a*); ſuch a Reaſon as any honeſt Author would be aſhamed of?

Can ſuch Men be deemed *Promoters* of Science, who thus labour to ſuppreſs ſo intereſting an Enquiry as that into the Nature and Uſes of that grand mechanical Agent, which is juſt now *diſcovered* by means of the electrical Apparatus? Was not my Aſſertion juſt, when I affirmed that they had arrogantly uſurped a Title and Office which they were unqualified for?

How contemptible muſt ſuch a Conduct render them, whilſt they thus baſely prevaricate, even when pretending to relate a plain Matter of Fact? May they not juſtly expect to ſhare the ſame Fate with the Shepherd's *lying* Boy in the Fable, who in Sport cried out, the Wolf! the Wolf! For if they are not to be believed when they are relating Facts, their Veracity may well, *like his*, be ſuſpected at other Times?

Such vile Proceedings are more than ſufficient to tempt us to ſuſpect that many Things which they are accuſed of by common Fame

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(*a*) Could they think of thus impoſing on me, without impoſing on the Public at the ſame Time?

are true, which are otherwiſe too atrocious to be credited, and which common Humanity would forbid us to believe where Men are not remarkably abandoned.——What can be more wicked than thus ſtudiouſly to bear Falſe-witneſs againſt their Neighbour, as they have done in the preſent Caſe?

Common Fame charges them with receiving a Bribe, in order to deal deceitfully with the *World*.—Common Fame affirms, that a certain Author wrote a Character of his own Book, and either brought or ſent it them, gilded with a Piece of Gold; which ſo far prevailed, that the Author's own Character of his own Work appeared in their Review, in the Front of their pretended Character. This Account I heard of ſo long ago as our former Diſpute, before my printed Letter to them in 1761 was publiſhed; but I could not help thinking it looked too much like downright Calumny to be credited: Indeed I then really thought they could not be guilty of ſuch very dirty Work; but my late Experience of the Malevolence of their Hearts, makes me fear, at leaſt, that they were capable even of ſo ignominious an Action.

To the many other Articles which conſtitute their true Character, that of Ingratitude might be juſtly added; of which the following is a remarkable Inſtance.

In their Review for March, 1773, p. 235, they are found diſplaying their Talents on *Marmaduke Berdoe*, M. D. concerning his

Doubts relating to the Inverſion of Objects at the Retina of the Eye, which they introduce with a Diſtich, borrowed from *Pope*'s Satires.

"Shut, ſhut the Door, good John! fatigu'd I ſaid,
"Tye up the Knocker,—ſay I'm ſick, I'm dead."

"Alas! *Pope*, (ſay they,) in his Eaſy-chair, 'and a ſtout Porter at his Gate, might ſay all 'this; but we poor Reviewers are not in a Si'tuation to give ourſelves thoſe Airs."

N. B. The next Lines exhibit an artful Contrivance to bring in the Public *Debtor* to them. "In an *evil* Hour—it is now—let us ſee '—three and twenty Years ago—we voluntarily undertook to recieve all Comers of what'ever Quality from the Preſs, and to give an 'Account to the Public of their Buſineſs (*a*).

"With reſpect to our preſent Viſitant (*b*); 'thrice already have we civilly,——much too 'civilly—out of mere Good-nature ſhewn him 'the Door, and we were in hopes that he would 'have taken the Hint. On the preſent Intru'ſion however, matters are now come to a criſis 'between us, and we find ourſelves under a Ne'ceſſity, for our own credit's ſake, abſolutely to 'turn him out by Head and Shoulders (*c*).

(*a*) In an *evil* Hour.——Here inſtead of gratefully acknowledging the Favours for which they ſtand deeply indebted to the Public, they begin their Harangue with an ungrateful Inſult upon their Benefactors.

(*b*) The Doctor.

(*c*) Could ſuch ruſtic Language become any Critics beſides ſuch *polite* ones as themſelves.

The above Tranſcript of their Remarks on Dr. *Berdoe*, being a curious Specimen of their *boaſted Civility* to him, induced me to preſent my Readers with it in this Place.

I cannot take leave of the *Monthly Reviewers* without obſerving to the Public, as well as to themſelves, the remarkable Difference of Sentiments between them and thoſe of the Authors of the *Critical Review*; the former ſhewing no Manner of Regard to the Importance of the Subject, whereas the latter point it out as highly worthy of the Purſuit of the Learned. Since they, far from ridiculing or contemning my feeble Pen, conferred a reſpectful Tribute of their Praiſe upon my Performance, and warmly recommended it as worthy the Peruſal and Attention of modern Philoſophers; and where they object to any thing that I have advanced, they do it with that Candour and Impartiality which will always mark a wide Diſtinction between the fair and judicious Critic, and the illiberal and incompetent Caviller.

To ſet this Affair in a proper Light, I think it incumbent upon me to recite the Remarks of the Authors of the latter upon the Subject at Length; and to endeavour to ſatisfy them in the Courſe of the Recital, in thoſe few Articles in which their Opinion differed from mine.

Critical Review, p. 281. " *It were unneceſſary*
' *to dwell on the Firſt Part of this Performance,*
' *as it conſiſts chiefly of a Recapitulation and Con-*
' *firmation of the Author's Opinions, contained in*
' *his*

'*his former Publications*; viz. *that the electrical Fluid is abſolutely and poſitively the ſame with Sir* Iſaac Newton'*s Æther. Beſides, the Subject is out of Date*;" (with Submiſſion, it is impoſſible for the Subject ever to be out of Date, ſince Fire is proved to be a *permanent* Principle;) "*and therefore we ſhall paſs on to Part the Second.*"

"*Having in the Firſt Part demonſtrated the electrical Fire to be Æther; he now proceeds to prove that Æther is the true elementary Fire, which he thus defines:*"

"1. *Fire is an Element in the ſtricteſt Senſe of the Word, and conſequently a permanent Principle.*"

"2. *It is in Form of an exceeding fine Air or Æther, and is by means of Electricity diſcovered to exiſt in the Pores of all groſs Bodies.*"

"3. *True Fire exiſts without a Pabulum, and conſequently yields neither Smoke, Aſhes, or any other groſs feculent Matter.*"

"4. *True Fire is either hot or cold, according to the Temperature of the Body in which it exiſts. Heat, according to our Author, is an accidental Property of Fire, generated by the mutual Attrition of the Particles of Fire.——That Heat is not an eſſential Property of Fire, he proves from electrical Experiments, particularly thoſe of* Dr. Franklin, *who melted Pins, Needles, Gold, and Glaſs, without the leaſt perceptible Warmth in the melted Bodies: And as a farther Proof of his Aſſertions, alledges, that, except Metals,*

' *nothing affords ſo great Plenty of electrical Fire* ' *as Water.*"

" *In conſidering Fire as a permanent Principle,* ' *though our Author differs from the generality of* ' *Philoſophers, who believe it to be nothing more* ' *than common Matter in violent Agitation, yet he* ' *is not ſingular in his Opinion; for ſuch was evi-* ' *dently the Sentiments of the indefatigable* Boer- ' haave, *as we learn from his Elements of Che-* ' *miſtry. Such was alſo the Opinion of the learned* ' *and ingenious Biſhop* Berkeley; *and ſuch was the* ' *Doctrine of many of the antient Philoſophers.*"

Anſwer. What you affirm is moſt certain; but indeed I had never preſumed to differ in Opinion from the generality of Philoſophers, relating to a Subject ſo abſtruſe and difficult as that of Fire was always allowed to be, had it not been for ſuch a remarkable and moſt reſplendent Beam of Light that was reflected on the Subject by electrical Experiments.—By means of which Light, we are now ſo happy as to ſee realized what former Philoſophers only conjectured, and who, conſequently, could reaſon on it but very imperfectly. —— What they could judge of from ſome of its remote Effects only, is completely demonſtrated to us by means of the plaineſt Facts.

Critical Review. " *In a Note on a Paſſage* ' *which our Author quotes from Biſhop* Berkeley, ' *in Proof of his own Opinion, he ſays, almoſt* ' *every Breath we reſpire, informs us that there* ' *is ſomething contained in Air, which is abſolutely* ' *neceſſary*

neceſſary to Life: This is verified if the Bed-clothes are but wrapped and confined cloſely about the Head, ſo that no freſh Air may have Room to paſs; for how ſoon after are we ſenſible of a Pain in the Cheſt; which increaſes in Proportion to the Number of Times the Air has been breathed."

" *We allow the Fact, but muſt reject it as a Proof of his Doctrine; for from the known Conſtruction of the Lungs, admitting the Air to contain that elementary Fire neceſſary to Life, there is no Reaſon to ſuppoſe that it enters the Body thro' that Organ rather than thro' the Pores of the Skin. Beſides, there is a much more rational Method of accounting for this Phenomenon, by conſidering the Air as a Menſtruum for Vapours of various Kinds. The ſame Air becomes unfit for frequent Reſpiration, becauſe it is ſoon ſaturated, and conſequently rendered incapable of abſorbing and carrying off thoſe noxious Exhalations from the Lungs, which being retained and accumulated, prove the Cauſe of Suffocation.*

Anſwer. Since the Fact is allowed, what I have advanced is no Way refuted or ſet aſide, the Fact itſelf being all I endeavoured to prove; *i. e.* that there appears ſomewhat in Air, ſo abſolutely neceſſary to Life, that if we are deprived of it, we very ſoon expire.

Critical Review. " *Paſſing over Matters of leſs import, we ſhall now proceed to* Ch. 5, Sect. 121, *which contains the Author's Theory of the Office of the Sun. Comparing the Macrocoſm, or great World, with the human Body, the Microcoſm, or*

' *World in Miniature, and thence reaſoning from Analogy, he ſuppoſes the Sun to be the* Cor Mundi *or* Primum Mobile, *which circulates thro' the Solar Syſtem that Æther, Fire, or electrical Fluid which gives Life, Motion,* &c. *to this Part of the Univerſe. But by what Means is this Circulation performed? This Queſtion we ſhall anſwer in the Author's own Words. But in order to comprehend him perfectly, it will be neceſſary to quote a paſſage from Sir* Iſaac Newton's *Optics, inſerted by our Author, and on which his Hypotheſis is founded. Every Body, ſays Sir* Iſaac, *endeavours to go from the denſer Part of the Medium towards the rarer; and if this Medium be rarer within the Sun's Body than at his Surface, and rarer there than at the hundredth Part of an Inch from its Body, and rarer there than at the fiftieth Part of an Inch, and rarer there than at the Orb of* Saturn, *I ſee no Reaſon why the Increaſe of Denſity ſhould ſtop any where, and not rather be continued thro' all Diſtances from the Sun to* Saturn *and beyond. And tho' this Increaſe of Denſity may, at great Diſtances, be exceedingly ſlow, yet if the elaſtic Force of this Medium be exceedingly great, it may ſuffice to impel Bodies from the denſer Parts of this Medium towards the rarer, with all that Power which we call Gravity. And that the elaſtic Force of this Medium is extremely great, may be gathered from the Swiftneſs of its Vibrations."*

" *Thus far, ſays our Author, Sir* Iſaac's *Opinion ſeems to coincide with the preſent Plan.*

'*Since then it ſeems reaſonable to ſuppoſe that the*
'*farther the Solar Rays proceed from him, the more*
'*denſe they are; conſequently when they have gone*
'*on ſo far as to meet with thoſe from the neareſt*
'*Syſtems around them, they muſt in thoſe far diſtant*
'*Regions be denſeſt of all. Is it not then natural*
'*to conclude, that at ſo denſe a Part of ſo extremely*
'*elaſtic a Medium, it muſt from thence return again*
'*to the moſt rare Part from whence it was ſent,*
'*and in its Progreſs cauſe the centripetal Force of*
'*the Planets?* i. e. *that Force which cauſes them*
'*to gravitate towards the Sun.*"

"*Doubtleſs there is ſome Ingenuity in this Hypotheſis,*
'*but it does not by any means follow from*
'*Sir* Iſaac'*s words above quoted --That great Philoſopher*
'*ſays no more than that Bodies floating in*
'*a Medium of different Denſity, will tend to the*
'*rareſt Part of that Medium; it does not therefore*
'*follow that the Medium itſelf muſt circulate.*"

Anſwer. That the Medium itſelf muſt circulate, cannot be reaſonably doubted, if we only conſider, that as the Sun's Rays are every Moment emitted from all the Parts of his Body, ſo there muſt neceſſarily, to maintain an Equilibrium, be as perpetual a Supply, and conſequently, that the Medium muſt therefore neceſſarily circulate.

Critical Review. "*Sir* Iſaac *never ſuppoſed*
'*Subtile Medium and the Rays of the Sun to be*
'*one and the ſame Thing.*"

Anſwer. Sir *Iſaac Newton* was not ſo happy as to be furniſhed with Experiments as we now are, to prove that Æther and Fire were the ſame Thing; nor was it poſſible in his Time to prove that the electric Fluid was actual Fire, notwithſtanding it is now ſo clearly verified to the Senſes; conſequently the Sentiments that Sir *Iſaac Newton* had then formed of it, cannot reaſonably be put in Competition with the Knowledge we now have of it, much leſs that we ſhould form our Sentiments of it from his: Nor can we have any Reaſon to doubt, whether the electrical Fire and the Rays of the Sun are one and the ſame Thing, ſince by our Experiments we not only find it to be Fire, but of the ſame Nature with the Rays of the Sun, and equally pure; ſince, like thoſe Rays in the Focus of a Burning-glaſs, it yields neither Smoke, Aſhes, nor other groſs Matter.

Critical Review, "*Nor can we poſſibly conceive what Power ſhould influence thoſe Rays, or elaſtic Particles to return from whence they came, after being propelled with a Force ſufficient to drive them beyond the Orb of* Saturn."

Anſwer. Sir *Iſaac Newton,* juſt now quoted, ſays, if the elaſtic Force of this Medium be exceedingly great, it may ſuffice to impel Bodies from the denſer Parts of this Medium towards the rarer, with all that Power which we call Gravity; and then goes on to prove, that, by means of the Swiftneſs of its Vibrations, the elaſtic Force muſt neceſſarily *be exceeding great.* Optics, Query 21

Critical Re•iew. "*The Fluids in the Micro-*
'*coſm are propelled through one Set of Veſſels,*
'*and return by another, and conſequently do not*
'*oppoſe each others Progreſs, which in the Ma-*
'*crocoſm, according to our Author's Syſtem, muſt*
'*neceſſarily happen.*"

Anſwer. If the Sun, as a Circulator, be appointed to propel the Æther to the utmoſt Bounds of the ſolar Syſtem, it cannot reaſonably be doubted but that a proper Proviſion is made, that ſo there be no Obſtruction in the Circulation of the Fluid, and that the Mode of the propelled, and that of the returning Medium are ſo differently circumſtanced as not to oppoſe or obſtruct one another in their Progreſs; and as the returning Part is evidently in Form of a Maſs, it is as clear that the Part propelled is in the Form of Darts or Rays; which being emitted with a Celerity equal to that of Light from the Sun, is ſufficient to penetrate the Maſs of the returning Æther, without either obſtructing, or being itſelf obſtructed. And this may not improbably be one principal Reaſon why the Sun was formed ſo vaſtly large; poſſibly the more effectually to render it capable of of performing ſuch a Taſk as that of milling up, of grinding, as it were, or attenuating the Æther, and darting it to ſuch an immenſe Diſtance, and penetrating even the Maſs of Æther itſelf: For had not the Sun been deſigned to ſerve ſome very extraordinary Purpoſes, a leſs Body might have been ſufficient.

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Critical Review. “ *In* Ch. 11, *he tranſcribes ‘ from Dr.* Hales’s *Vegetable Statics, that Au‘ thor’s Account of ſeveral Experiments relative ‘ to fixed Air, and in the following Chapter en‘ deavours to prove that this fixed Air is no other ‘ than the Subtile Medium of Sir* Iſaac Newton: *‘ But he ſeems not ſufficiently acquainted with the ‘ Properties of fixed Air to reaſon upon this ‘ Subject.*”

Anſwer. Nor could I ever meet with any one that was able to defend Dr. *Hales*’s Reaſoning, *viz.* to make out and explain what he means by *fixed Air*, ſo as to render it intelligible and ſatisfactory —I cannot indeed ſo much admire that the Doctor himſelf ſhould ſeem fond of his own *Creature*, as that he ſhould have ſo many who concur with him in ſo unnatural a Scheme as that of a *Tranſpeciation* of the Elements into each other.—In my humble Opinion, before it was affirmed that I ſeemed not ſufficiently acquainted with the Properties of fixed Air to reaſon on the Subject, it ſhould firſt have been ſhewn wherein my reaſoning on it was defective.

But however, I muſt not omit rendering my moſt grateful Acknowledgements to theſe judicious Critics, for treating the Performance in general in the candid Manner they have done; but eſpecially for the Character they have given it at the Concluſion of their Remarks, as in the following Words.

“ It is well known that many Attempts have ‘ been made towards reducing the Variation of

‘ the Needle to ſome certain Rule; but hitherto ‘ without Effect. The Author before us ſeems ‘ to have diſcovered the Laws by which this ‘ Variation is influenced; and, in conſequence ‘ of that Diſcovery, is of Opinion, that the ‘ Longitude at Sea may be found with great ‘ Accuracy. The principal difficulty ariſes from ‘ the general Imperfection of the Mariner's ‘ Compaſs-needles which are commonly uſed. ‘ His Theory is founded on a Suppoſition that ‘ the Magnetic Pole, to which the Needle ‘ points, makes a regular Revolution round the ‘ Pole of the Equator in a certain Number of ‘ Years. As to his Mode of Calculation, it ‘ were impoſſible to make it perfectly intelli‘gible without tranſcribing the greateſt Part of ‘ of his Appendix; and therefore we muſt refer ‘ ſuch of our Readers as are curious in theſe ‘ Matters to the Book itſelf, *which is evidently ‘ a Work of Genius, and by no means undeſerving ‘ the Peruſal of modern Philoſophers.*” See the Critical Review for October, 1766.

ariati-
n of the
mpaſs.

N. B. Since the Authors of the Monthly Review have thus endeavoured to impoſe on the *Public* in ſo groſs a Manner as they have done in the preſent Caſe, it is my humble Opinion they ought, in Juſtice to it, if they really pretend to know any thing of Electricity, to conſent to what I have formerly endeavoured to bring them to; *viz.* that in order to clear up the Diſpute between us on ſo curious, ſo intereſting,

ing, and copious a Subject as Electricity is allowed to be, that they would undertake to diſpute the Point fairly, *pro* and *con*, by the Channel of their Monthly Paper; and then, whatever Objection they might think proper to make, I would be ſure to reply to, and ſend it them Time enough to be inſerted in their next.—— A Correſpondence of this kind was ſolicited in my public Letter to them, and treated by them with their uſual Air of Contempt.

However, were they now to make a Reply, the ſame Excuſes which they then made would by no means ſerve their Turn; that Part of their Dialect is grown too ſtale to paſs current at this Time: That which they advanced eleven Years ago, when I firſt ſent them the ſame Invitation, would by no means now ſerve the Turn. —Their Reply to that Invitation being remarkably arrogant, I ſhall here repeat it.

"The Deſign of our Work (they ſay,) is
' miſtaken by ſuch who ſuppoſe it the Buſineſs
' of the Reviewers to ſet every *wrong-headed*
' *Author* right; or that they have arrogantly
' undertaken to ſupply every thing they may
' ſee wanting in the Works of others. They
' think it in general ſufficient that they point
' out the principal Defects in the Performances
' of ſuch miſtaken Writers; who would alſo
' do well, inſtead of obſtinately perſiſting in
' their Errors, and growing impatient at well-
' meant Reproof, *to ſubmit with Temper, and*

‘ *learn to profit by juſt Correction*” (a). See their Anſwer to my Reviewers Reviewed, 1761; or my Letter to them in the ſame Year, p. 24.

However, I am well aſſured that their Knowledge of Electricity is too ſuperficial to enable them to attempt any thing, either for it, or againſt it, by Way of Controverſy; and I challenge them, and all their Adherents, to enter into a fair and candid *Debate* on the Subject; and ſhould think it the greateſt Pleaſure to be engaged in ſo laudable a Diſpute with Perſons *capable* of refuting my Arguments, and thereby ſetting me right where I am wrong. But *they* muſt not think to *object* and *object*, and produce no Proofs to the contrary, as uſual, but Arguments more convincing will be expected, and ſuch as are ſupported with Experiments equally concluſive.

(a) And by ſuch Arrogancy, Evaſions, and Prevarications, inſtead of Argument, they ſhuffle off a ſerious and ſatisfactory Reply.

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A

GLOSSARY;

OR,

EXPLANATION

Of the more Uncommon WORDS.

A.

ABRASION, a ſhaving, or paring off.
Abſtruſe, not eaſy to be underſtood, difficult.
Accelerate, to haſten, or increaſe motion.
Accumulate, to heap up.
Adequate, equal, proportional.
Æther, a more pure and perfect air than that of the atmoſphere, the ſubtile medium diſcovered by the electrical apparatus.
Affluence, a flowing to.
Annihilate, to bring to nothing; to deſtroy utterly.
Analize, the reducing of any thing to its firſt principles.
Analytical Art, Algebra ſo called.
Antagoniſt, an oppoſer, or adverſary.
Apparatus, a collection of inſtruments uſed to ſhow experiments.
Aquatic, watery, or belonging to the water.
Arcanum, a ſecret.

Area, the ſuperficial content or meaſure of any thing.
Argument, a reaſon, or proof.
Atmoſphere, the lower part of the region of the air, with which our earth is ſurrounded.
Attraction, a drawing of one thing to another.
Attrition, rubbing, wearing, or fretting.
Aurora Borealis, the Northern Light.
Axiom, a plain ſelf-evident truth, or propoſition.

C.

Capſula, the caſe or huſk of any thing.
Caviller, one who pulls down and builds up nothing in its place.
Celerity, ſwiftneſs.
Center, a point equally remote from either of the extremities of a line, figure, or body.
Centrifugal, that endeavours to fly or go from the center.
Centripetal, whatever compels things towards their center.
Chaos, a confuſed jumble of things of different natures,
Circuit, any figure that begins and ends at the ſame point, as a circle, ellipſis, *&c.*
Coagulate, to congeal, curdle, or thicken.
Coalition, a growing together of parts in one maſs.
Coheſion, the action whereby the conſtituent particles of natural bodies are connected or joined together.
Colliſion, a ſtriking of one thing againſt another.
Combuſtible, any thing that eaſily takes fire, as oil, *&c.*
Concatenation, a linking, or tying things together.
Concentric, that hath one and the ſame center.
Condenſity, the reducing a body into a leſs compaſs.
Condenſing Phial, the collector of the electrical fluid.
Cone, a ſolid body, that has a circle for its baſis, and is terminated in a point at the top, called the vertex.
Conſectary, a conſequence or deduction.

Conſtituent, an eſſential part that compoſes any thing.

Contraction, a drawing up, or cloſing together.

Converging, an inclining or drawing towards each other.

Corollary, a conſequence or concluſion drawn or made from ſome antecedent demonſtration.

Corpuſcles, the ſmalleſt parts, or phyſical atoms of a body.

Criterion, the teſt or proof of the truth or falſhood of a thing.

Cube, a dye, a figure well known.

Culinary, belonging to the kitchen.

Current Philoſophy, the preſent eſtabliſhed philoſophy.

Cylinder, in the form of a garden rolling ſtone.

D.

Data, things known, given or granted in a propoſition.

Denſe, thick, oppoſed to thin.

Deſideratum, ſomething wanted or ſought for.

Dilatation, expanding to a greater bulk than common.

E.

Effluence, a flowing out.

Effluvia, ſmall particles of matter that fly off from bodies.

Egreſs, the act of going out.

Elaſticity, a ſpringineſs, or power to recover its former place when bent.

Electrical Fluid, or *Medium*, the medium diſcovered by the electrical apparatus.

Electrical Philoſophy, founded on the effects of experiments, or the diſcoveries made with the electrical apparatus.

Electricity, the power that amber, glaſs, ſealing-wax, *&c.* have when rubbed.

Electrometer, an inſtrument wherewith to aſcertain the meaſure of the force of electricity.

Electrics per ſe, thoſe bodies in which the electrical fluid is fixed.

Elementary Fire, fire ſo pure, as to yield neither ſmoke nor aſhes.

Elements, in natural philoſophy, pure and unmixed; the firſt principles or ingredients whereof bodies are compoſed; and are conceived to be ſimple and homogeneous

Epicycle, a little imaginary circle; invented to ſolve the ſtations and retrogradations of the planets.

Equilateral, a figure whoſe ſides are all equal.

Eſſential, the nature, ſubſtance, or being of a thing.

Expanſe, the firmament, or heaven.

F.

Feculent, full of dregs.

Fermentation, an inteſtine motion of the ſmall inſenſible particles of a mixed body.

Fluxion, a flowing or running.

Factitious, artificial, counterfeit.

Focus, the point of convergence or concourſe, where the rays meet and croſs the axis, after the refraction by the glaſs, or reflection by means of a concave mirror.

Force of Gravity, that quality which cauſeth bodies to tend to the center of the earth, or to each other.

Foſſils, all bodies that are dug out of the earth.

Friction, rubbing or chaffing.

Friblers, captious impertinent triflers.

G.

Genus, the ſtock or general name, comprehending the ſpecies under it.

Geometry, the art of menſuration.

Gravity, weight, *&c.*

Gravitation, the preſſure or action of an upper body upon another that is beneath it.

GLOSSARY.

H.

Heat, a peculiar quality of fire, excited by a mutual attrition of its particles.

Hemiſphere, half a ſphere.

Heterodox, contrary to received opinions.

Heterogeneous, compounded of things of a different nature, kind, or quality.

Homogeneous, of the ſame kind, nature, and properties.

Horizon, that great circle of the ſphere which divides the upper hemiſphere, or half compaſs of the heavens which we ſee, from the lower hemiſphere that is under us, and hidden from our ſight.

Horizontal Parallax, the difference between the true and apparent horizon.

Horſe-laugh, a noiſy roar when argument fails.

Hypotheſis, a ſuppoſition.

Hypercritic, a maſter critic, or over critical.

I.

Immaterial, a body not compoſed of groſs matter.

Immerged, dipped, or plunged into.

Immutable, unchangeable, fixed, unalterable.

Impel, driven, or thruſt forwards.

Impetus, the degree or force of motion impreſſed upon one thing by another.

Impregnate, to embody, ſoak, or drink in.

Impulſe, puſhing, or driving forwards.

Inanimate, without life or ſoul, lifeleſs, dead.

Inculcate, to inſtil, to repeat often, or get by little and little into a perſon's mind or underſtanding, any thing that we would teach or have him remember.

Incurvate, to bow or bend.

Indefinite, unbounded, unlimited, unreſtrained.

Inexplicable, that cannot be unfolded or explained.

Inflammable, capable of being ſet on fire.

Inflect, to bow or bend.

Ingenuous, free, honeſt, open, ſincere, plain.
Ingreſs, entrance into.
Inherent, innate.
Inſulate, cut off from all communication with the earth.
Interſtices, the pores of a body.
Intumeſcence, ſwelling, riſing, or puffing up.
Inveſtigate, tracing out, or proceeding ſtep by ſtep.

L.

Latent, concealed, lying hid.
Laudable, praiſe worthy, commendable.
Leyden Experiment, the electrical experiment firſt made by Profeſſor *Muſchenbroek*.

M.

Macrocoſm, the great world, or whole univerſe; in contradiſtinction to the microcoſm, or body of man.
Maſs, a heap or lump of any thing.
Material, any thing compoſed of matter or ſubſtance.
Medium, that peculiar conſtitution or frame of any ſpace thro' which bodies move, as the air, water, *&c.*
Meridian, a great circle paſſing thro' the poles of the world, and both the zenith and the nadir.
Metaphor, a figure in rhetoric, by which we put a ſtrange and remote word for a proper one.
Metaphyſics, the ſcience of immaterial beings.
Microcoſm, a little world, *i. e.* the body of a man; ſo called, as a kind of compendium of the greater.
Mundane, of or belonging to the world.

N.

Nadir, that point of the heavens which is directly under our feet.
Nature, the whole aſſemblage of created beings, and the orderly and regular ſucceſſion and generation of one thing out of, or from another.

Negative, a denying or gainſaying.

Negative Electricity, a mode of the electrical fluid, which, in particular circumſtances, appears as if in a ſtate of want.

Non-electrics, thoſe bodies in which the electrical fluid is not fixed, as metals, water, animals, vegetables.

Noſtrum, a ſecret in any art or ſcience known to few.

Noxious, hurtful, miſchievous.

O.

Oblivion, forgetfulneſs.

Occult, dark, hidden, unknown, ſecret.

Ocular, belonging to the eyes or ſight.

Optics, the ſcience of viſion.

Orbit, the line deſcribed by any thing that moves round. In aſtronomy, it is that path in which a planet moves.

Ore, metal mixed with the earth of the mine, unrefined.

Orthodox, that is of a true or right opinion or belief.

Oſcillation, a ſwinging up and down, a vibration like the pendulum of a clock.

P.

Pabulum, to feed or recruit.

Parallax horizontal, the difference between the real and apparent horizon.

Perforation, a boring through.

Permeate to penetrate into or through the pores of any body.

Pervade, to go through.

Phenomena, appearances of meteors, or any other ſigns, in the air or heavens.

Phyſical, natural, belonging to natural philoſophy.

Phyſiological, relating to the knowledge of the nature of things.

Plane, any extended flat ſuperficies.

Plane of the Horizon, the plane that bounds the ſight.

Pneuma, the fine ſpirit or eſſence of æther.

Pneumatics, treats of the properties of the air.

Poles, the points upon which the imaginary axis of the world, or any particular globe, turns.

Poſitive Electricity, real or true electricity.

Poſteriori, a mode of arguing from the effect to the cauſe

Predominant, bearing chief ſway, or over-ruling.

Previous, leading the way, or going before.

Prime Conductor, that which conducts the electrical fluid immediately from the excited glaſs globe.

Primum mobile, the principal or moving cauſe.

Principle, the firſt cauſe of the being or production of any thing, a motive or inducement.

Priori, a mode of reaſoning from the cauſe to the effect.

Problem, ſomething propoſed to be done, and is uſually underſtood of conſtructing mathematical figures, and demonſtrating the truth and reaſon of the proceſs uſed to effect it.

Projectile, thrown or caſt with a conſiderable force.

Propelled, driven forward, or thruſt afar off.

Proceſs, the whole courſe of any operation or experiment.

Pro re nata, occaſionally.

Pulſion, the driving or forcing any thing forward.

R.

Rare, a very thin medium.

Rarefaction, when a body occupies more ſpace than uſual.

Rarity, or *Rareneſs*, the thinneſs of the air, *&c.*

Realize, to make, cauſe, or produce any being or thing.

Recapitulate, to ſum up the heads of a former diſcourſe.

Recede, to go back or retire, to depart from.

Receſs, a retreating, going back, or withdrawing.

Reciprocal, mutual, that is returned on both ſides.

Rectilinear, any figure conſiſting of right lines.

Redintigrate, to renew, or make afreſh.

Reflection, the returning back of rays of heat or light, by ſtriking upon a hard body.
Refract, to break back again, to reſiſt.
Refraction, the breaking of the natural courſe of a ray.
Refrigeratory, a veſſel to cool things in.
Repel, to beat or drive back.
Replete, full, filled, repleniſhed.
Reprehend, to reprove or rebuke.
Repulſe, to reſiſt, refuſe, oppoſe, or beat back.
Reſpiration, breathing; an alternate dilation and contraction of the thorax, whereby the air is taken in by the wind-pipe, and by and by driven out again.
Retina, a certain expanſion of the inner ſurface of the optic nerve of the eye.
Retrogradation, a going back.
Reveries, mad or idle talk, conceits or fancies.
Rotation, an orderly and regular moving round or ſucceſſion.
Rodomantade, a vain-glorious bragging or boaſting.

S.

Sanguine, being earneſt in, or zealous for any thing.
Sceptic, one who diſbelieves, or at leaſt doubts the truth of, all things.
Scholium, a remark or obſervation made upon a propoſition, or conſequence drawn from a demonſtration.
Secretion, the ſeparation of one fluid from another in the bodies of animals and vegetables.
Segment of a Circle, a part cut off from it.
Segregate, to ſeparate or put apart.
Semi-diameter, the radius, or half of the diameter.
Semi-metals, mineral bodies half metallic; ſuch as antimony, biſmuth, &c.
Simultaneous, acting together; exiſting at the ſame time.
Solar, belonging or relating to the ſun.
Sophiſm, a fallacious reaſon, or one that has only an appearance and not the reality of truth.

Sphere, a globe or round body, contained under one continued regular ſurface, from the center whereof to the ſurface all lines drawn are equal.

Spheroid, a ſolid figure ſomewhat reſembling a ſphere, but not perfectly round.

Spiral, that which turns round like a ſcrew.

Square, a geometrical figure compoſed of four equal ſides.

Stricture, ſtrict remarks.

Subduple, any thing that is half of another, as the root is the ſubduple of the power of it; or as the number 2 is the ſubduple of 4.

Sublimation, the raiſing of ſolid and dry bodies by fire.

Sublunary, under the orb of the moon.

Subtile, thin, light, fine, pure, unmixed, ſeparated from all groſs matter.

Subterfuge, an excuſe, pretence, evaſion, ſhift, *&c.*

Subterraneous, that lies under the ſurface of the earth.

Succinct, brief, ſhort, comprehended in a few words.

Sui Generis, of its own kind.

Syſtem, a compleat treatiſe, or body of any art or ſcience.

Synthеſis, compoſition, or joining things in a regular manner together.

Synonymous, two names which have but one meaning.

Sexagenary Arithmetic, that which proceeds by ſixties; as the diviſion of circles into 60 degrees, every degree into 60 minutes, every minute into 60 ſeconds, *&c.*

T.

Tangent, is a right line drawn without a circle, perpendicular to ſome radius or ſemi-diameter.

Tangible, whatever is the ſubject of the ſenſe of feeling.

Tenet, a doctrine or opinion.

Terraqueous, belonging to the earth and water mixed.

Teſt, a proof or trial.

Theory, the contemplation or ſtudy of art or ſcience, without practice.

GLOSSARY.

Thermometer, an inſtrument to ſhow the ſeveral degrees of heat and cold

Thorax, the breaſt or cheſt, containing the heart, lungs, &c.

Toiſe, a French meaſure, about the length of ſix feet.

Tarricellian, the device of the quickſilver weather-glaſs, ſo called from the inventor.

Tranſmutation, changing or converting one ſubſtance or figure into another.

Tranſpeciation, the changing one ſpecies into another.

U.

Unctuous, oily, fat, greaſy, &c.

Undulate, to flow in waves like water.

Univerſe, the whole creation, the frame or maſs of material beings.

Vacuum, a ſpace diveſted of all body.

Vapid, palled, deadened, or grown flat.

Vapour, a watery exhalation.

Vegetate, to grow as plants.

Vehicle, a general name for that which ſerves to carry or bear any thing along, as the ſerum is a vehicle for the red globules of the blood.

Velocity, the ſwiftneſs by which a body paſſes a certain ſpace in a certain time.

Verſed Sine, that part of the diameter of a circle which is comprehended between the ſine and the tangent of an arch.

Vertex. the ſummit or uppermoſt part of any thing.

Vibration, a very quick and ſhort motion of the ſolid parts of bodies.

Z.

Zenith, that point of the heavens which is directly over our heads.

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